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NONPOINT SOURCE POLLUTION ASSESSMENT OF THE CHEMUNG AND SUSQUEHANNA RIVER SUBBASINS

DEC 24, 1970

SUSQUEHANNA RIVER BASIN COMMISSION

RESOURCE QUALITY MANAGEMENT & PROTECTION DIVISION

SEPTEMBER 1975

SUSQUEHANNA RIVER BASIN COMMISSION

ROBERT J. BIELO
EXECUTIVE DIRECTOR

NONPOINT SOURCE POLLUTION ASSESSMENT
OF THE
CHEMUNG AND SUSQUEHANNA RIVER SUBBASINS

PREPARED BY:

CHARLES S. TAKITA
SANITARY ENGINEER

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MECHANICSBURG, PENNSYLVANIA 17055

TELEPHONE: 717 - 737-0501

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ABSTRACT

The assessment of nonpoint source pollution in the Chemung and Susquehanna Rivers upstream of Sayre, Pennsylvania was conducted to identify problem areas and to provide priorities for further detailed studies. Data available through other collection agencies were utilized and field data collection was not attempted.

Results of analyses of flow-concentration relationships suggest that nonpoint sources of NO_3-N exert a major influence throughout the Chemung and Susquehanna Rivers. Results of analyses also indicated nonpoint source influence of organic nitrogen in the Cohocton River and the Chenango River drainage areas and nonpoint source influence of PO_4-P in the Cohocton River drainage area. Results of analyses for the remainder of the subbasin indicated smaller influence from nonpoint sources and that the primary sources of nutrients in these areas were point sources.

The greatest contribution of nutrient loads to the Susquehanna system above Sayre, Pennsylvania appears to be derived from the Chenango River drainage area.

INTRODUCTION

Purpose

Nonpoint source pollution, or pollution from a diffuse source such as runoff not confined by any discernible and discrete conveyance amenable to discharge regulation, affects nearly all streams in the Susquehanna River Basin to some extent. The purpose of the project is to assess the problem, identify problem areas and ultimately recommend a control program based upon the impact identified nonpoint source pollution has upon stream quality.

Scope

This report encompasses the northern part of the Susquehanna River Basin in New York and Pennsylvania that lies within the Appalachin Plateau physiographic province upstream of Sayre, Pennsylvania as shown in Figure 1. The major part of the study area is located in the following counties:

New York - Steuben, Chemung, Tioga, Broome, Cortland,
Chenango, Madison, Otsego and Delaware Counties;

Pennsylvania - Tioga and Potter Counties.

The Susquehanna River subbasin in New York was further divided into the Susquehanna River drainage area and the Chenango River drainage area as shown in Figure 1 for the purposes of this report and will be referred to as such in discussing the individual drainage area. The term subbasin will be used when reference is made to the Susquehanna River subbasin as a whole.

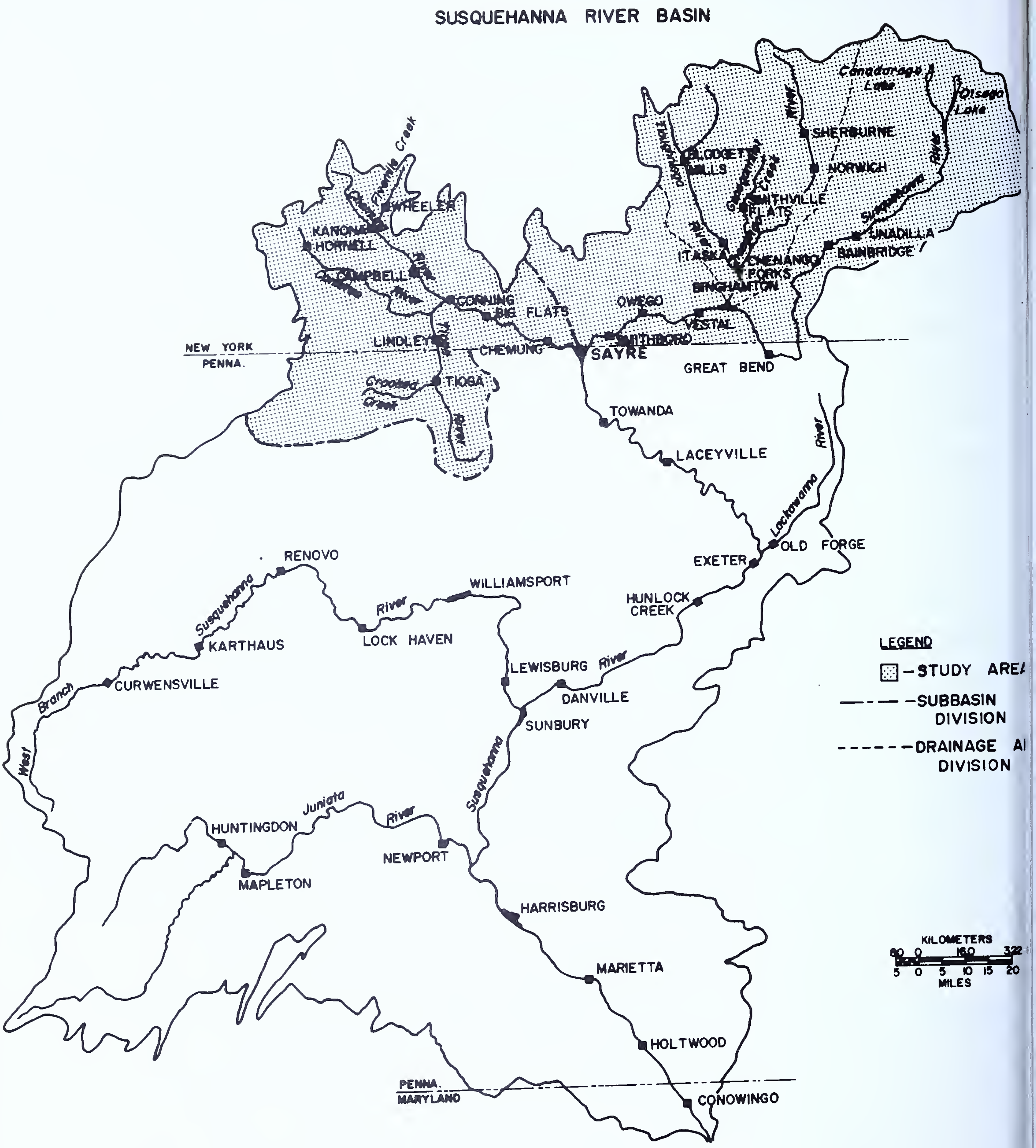

Figure 1 -- Map of Susquehanna River Basin Showing Area of Report

Certain limitations on the study should be recognized. The assessment is based upon data available from other agencies. In using the available data, limitations include: (1) sampling sites were not ideally located, (2) analyses of grab samples do not reflect conditions throughout the cross-section - both laterally and vertically, and (3) the length of sampling period and sampling frequency (monthly) occasionally were not sufficient to enable a detailed analysis or in some cases to permit a gross analysis of the nonpoint source pollution impact.

Water Quality Program

The Susquehanna River Basin Compact confers broad powers upon the Commission for the management of the water and related resources of the Susquehanna River Basin which includes water quality management and control. The Commission's intended exercise of its authority is articulated in its Comprehensive Plan for the immediate and long-range development and use of the water and related resources of the Basin. The Comprehensive Plan defines the immediate role of the Commission's efforts regarding water quality as: coordination of the efforts of Federal, State and local pollution control and management; evaluation of the effectiveness of adopted water quality standards; and direction of attention to special problems. Special water quality problems from point and nonpoint sources include acid mine drainage, effects of heated effluents and nutrient pollution.

ACKNOWLEDGMENTS

Appreciation is expressed to the Department of Environmental Conservation and Office of Planning Services, State of New York, and U.S. Soil Conservation Service and Geological Survey for their invaluable cooperation and assistance in providing information for this study.

PHYSICAL SETTING

Topography and Drainage

The area discussed in this report (Figure 1) is the northern part of the Susquehanna River Basin in New York and Pennsylvania that lies within the Appalachian Plateau physiographic province. Continental glaciation of this northeastern section of the province has produced well-rounded hills and broad, flat valleys. The hills rise, as a general rule, from 500-800 feet above the valleys with comparatively steep, symmetrical slopes (Susquehanna River Basin Study Coordinating Committee, 1970). Plate 1 illustrates the general gradient and variability of slopes in the Upper Susquehanna River Basin. The Susquehanna River subbasin has a generally flatter terrain than the Chemung River subbasin, which is characterized by predominantly steeper slopes.

The drainage area of the Susquehanna River subbasin above the mouth of the Chemung River is about 4,944 square miles with an average stream gradient of 2.8 feet/mile. There are three major tributaries to the Susquehanna River in New York: (1) the Chenango River flows in a southwesterly direction for about 50 miles to Binghamton where it joins the Susquehanna River. The gradient of the Chenango River varies from 18 feet/mile in the upper reaches to 3.4 feet/mile in the middle and lower reaches with an average gradient of about 6 feet/mile., (2) the Tioughnioga River, which is about 50 miles in length and has an average gradient of 10 feet/mile, and (3) the Unadilla River which is about 65 miles in length and has an average gradient of 8 feet/mile.

The Chemung River, formed by the confluence of the Cohocton and Tioga Rivers at Corning, New York, flows in a southeasterly direction for about 45 miles to its junction with the Susquehanna River below Athens, Pennsylvania. The streambed is wide with steep sides. The drainage area of the Chemung River is 2,596 square miles at its mouth with an average stream gradient of 4 feet/mile. The tributaries of the Chemung are generally steep and narrow, and flow through rugged terrain. The Tioga River, which originates near Covert, Pennsylvania, is about 45 miles long and flows in a southwesterly direction to Blossburg, Pennsylvania, then northerly to Corning, New York. The Tioga River has an average stream gradient of 25 feet/mile. The Cohocton River is about 55 miles long and has an average stream gradient of 17 feet/mile. A major tributary to the Tioga River is the Canisteo River. It is about 55 miles long with stream gradients ranging from 76 feet/mile in the headwaters to 5 feet/mile in the lower reaches. The average gradient for the Canisteo River is about 20 feet/mile.

Climate and Runoff

The climate in the Susquehanna River Basin in New York is classified as humid-continental marked by seasonal extremes of heat and cold. The mean annual temperature is 46°F. with extremes ranging from -30°F. to 102°F. Precipitation is fairly uniform throughout the year, although there is some increase in rainfall during the warmer season (Figure 2). The average monthly

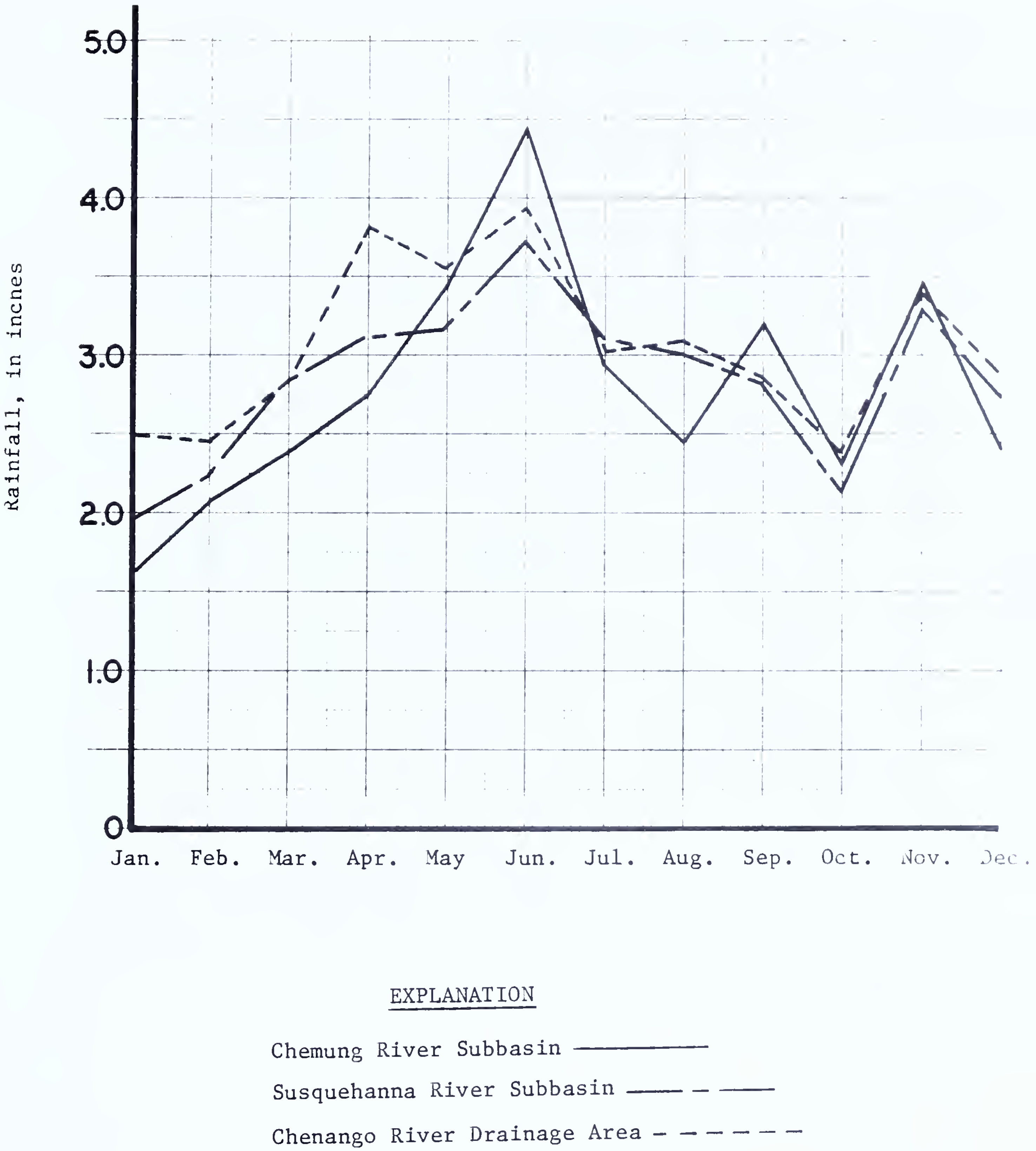

Figure 2 -- Graph Showing Average Monthly Rainfall in the Chemung River and Susquehanna River Subbasins.

and average annual precipitation for the Chemung River subbasin, Chenango River drainage area and Susquehanna River drainage area are shown in Table 1.

For the purpose of data evaluation, the year was divided into low, moderate and high flow periods based on stream flows. The low flow period includes the months of July through October; moderate flow, the months of November through February; and the high flow period includes the months of March through June. The average flows for these periods are as follows:

	Chemung River Subbasin	Susquehanna River Subbasin
Flow Period	Average Flow (cfs)	Average Flow (cfs)
July-October (Low)	393	2,136
November-February (Moderate)	1,802	11,187
March-June (High)	3,908	13,832

The above flows are based on monitoring data recorded at Chemung and Smithboro, New York. Data near the mouth of the Chenango River was not available.

Soils

Soils on the hills are developed in glacial till comprised largely of local sandstone and shale. The stream valleys are moderately wide with steep sides and flat valley floors underlain by deep deposits of glacial out-wash and alluvial materials. Soils on the moderately sloping areas are mostly deep and moderately to poorly drained and on the steeper hillsides they are moderately

TABLE 1
AVERAGE MONTHLY AND YEARLY PRECIPITATION FOR THE CHEMUNG RIVER AND SUSQUEHANNA RIVER SUBBASINS

Sub-basin	Recording Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Yearly
Chemung	Hornell Almond Dam W. Jasper Thurston	1.56	2.06	2.37	2.73	3.45	4.43	2.91	2.42	3.20	2.29	3.45	2.39	33.26
Chenango	Binghamton East Homer Hunts Corners Plymouth Smithville Flats Whitney Point	2.99	2.43	2.80	3.80	3.55	3.93	3.03	3.08	2.86	2.36	3.39	2.86	36.58
Susquehanna	Arnot Lodge Newark Valley East Sidney Davenport Edmeston	1.93	2.21	2.82	3.12	3.17	3.73	3.10	3.01	2.84	2.14	3.30	2.75	34.12

deep and well drained. Many soils have developed impermeable layers at depths of one to two feet below the surface. These retard downward movement of water and result in wet soils (Susquehanna River Basin Study Coordinating Committee, 1970).

Some of the more important upland soils are:

1) Mardin - deep, moderately well drained
2) Volusia - deep, poorly drained
3) Lordstown - moderately deep, well drained.

The principal valley soils are:

1) Chenango - deep, well drained, gravelly terrace
2) Braceville - moderately deep, well drained terrace
3) Howard - deep, well drained, gravelly terrace
4) Middleburg - deep, moderately well drained flood plain
5) Holly - poorly drained flood plain.

Land Use

The Susquehanna River Basin in New York is comprised of 36.8 percent agricultural lands, 56.6 percent woodlands, 1.7 percent open waters, and 1.9 percent urban lands. The remaining 3 percent of the land consists of quarry operations, highways, airports, railways, recreational areas, public lands, and rural estates. Acreages and percentiles of selected land use categories in the Susquehanna River Basin in New York are as follows:

	Acres	Percent
Agriculture	1,620,254	36.8
Woodland	2,491,939	56.6
Water	76,682	1.7
Gravelpit, Quarries	14,988	0.3
Urban	82,802	1.9
Other	115,607	2.7
TOTAL --	4,402,272	100.0

Comparison of the generalized slope map (Plate 1) and the generalized land use maps (Plates 2 and 3) show that the agricultural and urban lands are generally located in the flatter river valleys with the woodlands located on the higher and steeper slopes. Of the total land area in the New York part of the Susquehanna River Basin, 42 percent lies within the Susquehanna River drainage area, 23.3 percent in the Chenango River drainage area and 34.7 percent in the Chemung River subbasin. Acreages and percentages of the total area of the selected land use categories lying within the three major drainage areas in New York are shown in Table 2. Agricultural lands are well distributed throughout the Susquehanna River drainage area and Chemung River subbasin with slightly more being located in the Chemung River subbasin. The Susquehanna River drainage area contains more woodlands and urban areas. Over half of the area in gravel pits and quarries is located in the Chemung River subbasin.

Percentages of the selected land use categories for each of the drainage areas are shown in the following table.

Land Use	Susquehanna R.	Chenango R.	Chemung R.
Agriculture (%)	33.3	37.0	40.9
Woodland (%)	57.4	58.1	54.6
Water (%)	2.1	1.9	1.1
Gravelpit, Quarries (%)	0.3	0.1	0.5
Urban (%)	2.1	1.8	1.7
Other (%)	4.8	0.1	1.1

Acreages and percentages of agricultural land in cropland,

TABLE 2

PERCENTAGE OF TOTAL LAND USE WITHIN DRAINAGE AREAS

	Susquehanna River		Chenango River		Chemung River	
	Acres	%	Acres	%	Acres	%
Agriculture	615,639	38.0	379,662	23.4	624,953	38.6
Woodland	1,060,421	42.6	596,628	23.9	834,890	33.5
Water	38,774	50.6	20,424	26.6	17,484	22.8
Gravelpit, Quarries	5,083	33.9	1,439	9.6	8,466	56.5
Urban	33,569	46.6	18,336	22.1	25,897	31.3
Other	88,377	76.4	9,774	8.4	17,451	15.1
TOTALS	1,846,863	42.0	1,026,268	23.3	1,529,141	34.7

grazing and other lands (i.e. farmsteads, roadway, barns, etc.) are shown in Table 3. Cropland is further subdivided into types of crop harvested. There is very little difference in the acreages for grazing and cropland for the Susquehanna River drainage area and the Chemung River subbasin.

Animal concentration is highest in the Chenango River drainage area and least in the Chemung River subbasin (Table 3).

TABLE 3

DISTRIBUTION OF AGRICULTURAL LAND AND ANIMAL CONCENTRATIONS IN EACH DRAINAGE AREA

Drainage Area	AGRICULTURAL LAND													ANIMAL		
	Total Acres	Cropland								Grazing		Other		CONCENTRATION		
		Total		Wheat, Hay, Alfalfa		Potato, Veg., Other		Corn								
		%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	Total	%	#/Acre
Susquehanna River Basin, N.Y.	1,620,254	49.6	803,936	82.0	659,028	3.2	26,092	14.7	118,816	26.4	427,280	24.0	389,028	183,875	100	0.4
Susquehanna River	615,639	50.9	313,360	80.8	253,195	1.8	5,640	17.4	54,525	26.4	162,529	22.7	159,750	75,190	40.9	0.5
Chenango River	379,662	47.9	181,850	82.6	150,208	1.4	2,546	16.0	29,096	27.1	102,888	25.0	94,915	74,365	40.4	0.7
Chemung River	674,953	49.4	308,726	82.8	255,625	5.8	17,906	11.4	35,195	25.9	161,863	24.7	154,363	34,320	18.7	0.2

NONPOINT SOURCE POLLUTION ASSESSMENT
OF THE
CHEMUNG AND SUSQUEHANNA RIVER SUBBASINS

Appraisal By Subbasin

Chemung River Subbasin

Mean concentrations of NO_3-N, organic nitrogen and PO_4-P during each flow period for the Chemung River subbasin are shown in Table 4. All concentrations recorded met the New York State Stream Standards. The highest NO_3-N concentrations were recorded in the Cohocton River drainage area during the moderate flow period. Stations at Wheeler, Kanona and Campbell in the Cohocton River drainage area had an average of 1.27, 1.17 and 1.93 mg/l NO_3-N, respectively, during the moderate flow period, with almost a 50 percent decrease in concentration during the high flow period. Generally, the NO_3-N concentrations during the high flow periods showed an increase over those of the low flow period and an increase in concentration downstream between Wheeler and Campbell. A station in Hornellsville in the upper reaches of the Canisteo River showed a maximum 1.26 mg/l NO_3-N during the low flow period, with decreasing concentrations as the flow increased. No other water quality data was available for the Canisteo River below Hornellsville. In the Tioga River drainage area, the highest concentrations of NO_3-N (1.36 and 1.49 mg/l) occurred at Corey Creek and Elk Run near Mainsburg, Pennsylvania. Data at all stations except Lawrenceville in this drainage area also showed an increase in concentration during the high flow periods. Data

TABLE 1
AVERAGE NO_3-N, ORGANIC N AND PO_4-P CONCENTRATIONS FOR THE CHEMUNG RIVER SUBBASIN IN MILLIGRAMS PER LITRE

Station	Instantaneous Flow, cfs			NO_3-N			Org. N			PO_4-P		
	Jul.-Oct.	Nov.-Feb.	Mar.-Jun.	Jul.-Oct.	Nov.-Feb.	Mar.-Jun.	Jul.-Oct.	Nov.-Feb.	Mar.-Jun.	Jul.-Oct.	Nov.-Feb.	Mar.-Jun.
Five Mile Crk. at Wheeler	11	46	298	0.48	1.27	0.71	0.38	0.32	0.88	0.17	0.17	0.33
Five Mile Crk. at Kanona	7	55	119	0.41	1.17	0.68	0.64	0.26	0.82	0.17	0.24	0.32
Cohocton River at Campbell	84	294	696	0.55	1.93	0.87	0.44	0.48	0.54	0.31	0.21	0.29
Chemung River at Corning				0.21	0.64	0.61	0.53	0.36	0.57	0.32	0.25	0.30
Chemung River at Big Flats				0.25	0.63	0.60	0.55	0.39	0.84	0.55	0.32	0.30
Chemung River at Chemung	393	1802	3908	0.63	0.94	0.74	0.60	0.42	0.67	0.99	0.49	0.39
Canisteo River at Hornellsville				1.26	0.84	0.82	0.79	0.92	0.66	1.71	1.34	0.78
Tioga River at Lindley	100	582	1239	0.22	0.58	0.43	0.41	0.39	0.52	0.29	0.17	0.25
Cowanesque River at Lawrenceville	86	252	598		0.86	0.77				0.08	0.05	0.28
Tioga River at Tioga Junction	276	406	865	0.17	0.21	0.44				0.01		0.05
Corey Creek near Mainsburg, Pa.				0.11	1.36	0.42						
Elk Run near Mainsburg, Pa.				0.11	1.49	0.47						

for the low flow period at Lawrenceville was not available.

Maximum NO_3-N concentrations on the Chemung River drainage area occurred at Chemung, New York. Similar to all of the other stations in the Chemung River subbasin, NO_3-N concentrations during the higher flow periods showed an increase over those of the low flow period and an increase in concentration downstream between Corning and Chemung.

Nearly all stations in the Chemung River subbasin had the highest concentrations of NO_3-N during the moderate flow-low temperature period when biological utilization is lowest.

Organic nitrogen concentrations in the Cohocton River drainage area were highest at Wheeler and Kanona (0.88 and 0.82 mg/1 respectively). The average concentrations at Wheeler and Kanona indicate that organic nitrogen concentrations decrease initially (dilution of point source input) during the moderate flow period and then increases significantly during the high flow period when runoff into the stream is highest. The station at Campbell on the Cohocton River downstream from Wheeler and Kanona shows some increase in concentration as the flow increases. Organic nitrogen concentrations at Hornellsville show initial increases in concentration (0.92 mg/1, highest in the Chemung River subbasin) during the moderate flow period and then decrease as flows continue to increase. Concentrations at Lindley, New York, on the Tioga River, show a slight increase during the period of greatest flows similar to that at Wheeler and Kanona. Data for the reach of the Chemung River between Corning and Chemung also shows some decrease then an increase in organic nitrogen concentrations with increased flows similar to that found in the Cohocton drainage area.

The majority of the stations in the Chemung River subbasin show smaller PO_4-P concentrations during the higher flow periods. The highest concentrations of PO_4-P were found at Hornellsville (1.71 mg/1) in the upper reaches of the Canisteo River and at Chemung (0.99 mg/1) on the Chemung River. Average seasonal concentrations at Wheeler and Kanona, both located on Five Mile Creek, a tributary to the Cohocton River, indicate that PO_4-P concentrations increase with increasing flows. A similar phenomenon appears to occur at Lawrenceville, Pennsylvania, on the Cowanesque River tributary to the Tioga River and at Tioga Junction on the Tioga River.

Regression analyses on the relationship between flow and concentrations of NO_3-N, organic nitrogen and PO_4-P were conducted for all stations with sufficient flow data. The results of the analyses generally agreed with the data presented in the above tables with regard to increases or decreases in concentrations. Regression analyses are shown graphically with the 90% confidence intervals in Figures 3-7 (see Appendix). The analysis for the NO_3-N and flow relationship indicates that the NO_3-N concentrations increase at all stations, except at Chemung, during higher flows. Although the average NO_3-N concentrations at Chemung as shown in Table 4 are greater during higher flows, regression analysis of the data indicate a decrease in concentration during higher flows. Additional data is needed to clarify this difference. The positive relationships imply that nitrates are being contributed from nonpoint sources because normal expectations would be that the relatively uniform flows and concentrations from point sources would be diluted as stream flow increases. The regression analyses of data from Wheeler, Kanona, Campbell, and Lindley shows definite positive slopes, which implies a significant contribution from nonpoint sources (Figures 3-7).

Analyses of organic nitrogen show positive slopes at all stations analyzed. Nonpoint source contributions appear to be most significant at Wheeler. The analyses for PO_4-P indicate that nonpoint sources may be significant contributors of PO_4-P at Wheeler and Kanona located on Five Mile Creek tributary to the Cohocton River. Results at Campbell, Lindley and Chemung show a negative slope implying that point sources are the primary contributor of PO_4-P.

Average loadings for each of the flow periods are shown in Table 5. The NO_3-N, organic nitrogen and PO_4-P loadings at each sampling station increases with increased flows. The loadings for most stations also show an increase in the downstream direction indicating substantial inputs from other tributary watersheds. Exception to this downstream increase was noted in the Tioga River drainage area stations at Lindley, Lawrenceville

TABLE 5
AVERAGE NO_3-N, ORGANIC N AND PO_4-P LOADINGS
FOR THE CHEMUNG RIVER SUBBASIN,
IN POUNDS PER DAY

Station	Instantaneous Flow, cfs			NO_3-N			Org. N			PO_4-P		
	Jul.-Oct.	Nov.-Feb.	Mar.-Jun.	Jul.-Oct.	Nov.-Feb.	Mar.-Jun.	Jul.-Oct.	Nov.-Feb.	Mar.-Jun.	Jul.-Oct.	Nov.-Feb.	Mar.-Ju
Five Mile Crk. at Wheeler	11	46	298	31	286	1118	23	79	1413	11	42	598
Five Mile Crk. at Kanona	7	55	119	22	380	911	24	77	526	9	70	484
Cohocton River at Campbell	84	294	696	564	3528	3817	199	761	2026	140	353	917
Chemung River at Big Flats	1213	3155	2764	1264	4338	7784	3596	6632	12514	1194	3313	3990
Chemung River at Chemung	393	1802	3908	2889	10874	24383	1271	4079	14113	4314	5333	12062
Tioga River at Lindley	100	582	1239	130	1707	2508	221	1223	3473	156	512	1039
Cowanesque River at Lawrenceville	86	252	598		4032	8899				37	65	2047
Tioga River at Tioga Junction	276	406	865			11722				2		309

and Tioga Junction. The data shows substantially larger loadings at Lawrenceville and Tioga Junction over that at Lindley which is downstream. Data from Lawrenceville and Tioga Junction were severely limited; therefore, no conclusive statements can be made.

The Cohocton River drainage area appears to be a greater contributor of NO_3-N than the Tioga River drainage area as reflected by the loadings shown in Table 5 for Campbell and Lindley. The flows at Campbell, on the Cohocton, are less than for the Tioga River at Lindley, but the loadings were considerably higher. Data for the Canisteo River was not available to make similar comparisons.

The results of the U.S. Geological Survey's "Appraisal of Stream Sedimentation in the Susquehanna River Basin" (Williams and Reed, 1972) indicate that the Canisteo River drainage area has a consideraly higher sediment yield than the Cohocton and the Tioga River drainage areas which had similar yields (Figures 8 and 9). An analysis conducted by the Environmental Protection Agency Annapolis Field Office in their Nutrient Transport Study for the lower Susquehanna River Basin (Clark, Guide & Pheiffer, 1974), indicated a definite relationship between sediment load and organic nitrogen and TP loads. If a similar relationship exists in the Chemung River subbasin, the Canisteo River drainage area may have considerable organic nitrogen and TP loadings. No definite relationship could be established by EPA for NO_3-N.

Land use data indicate that the drainage areas for the

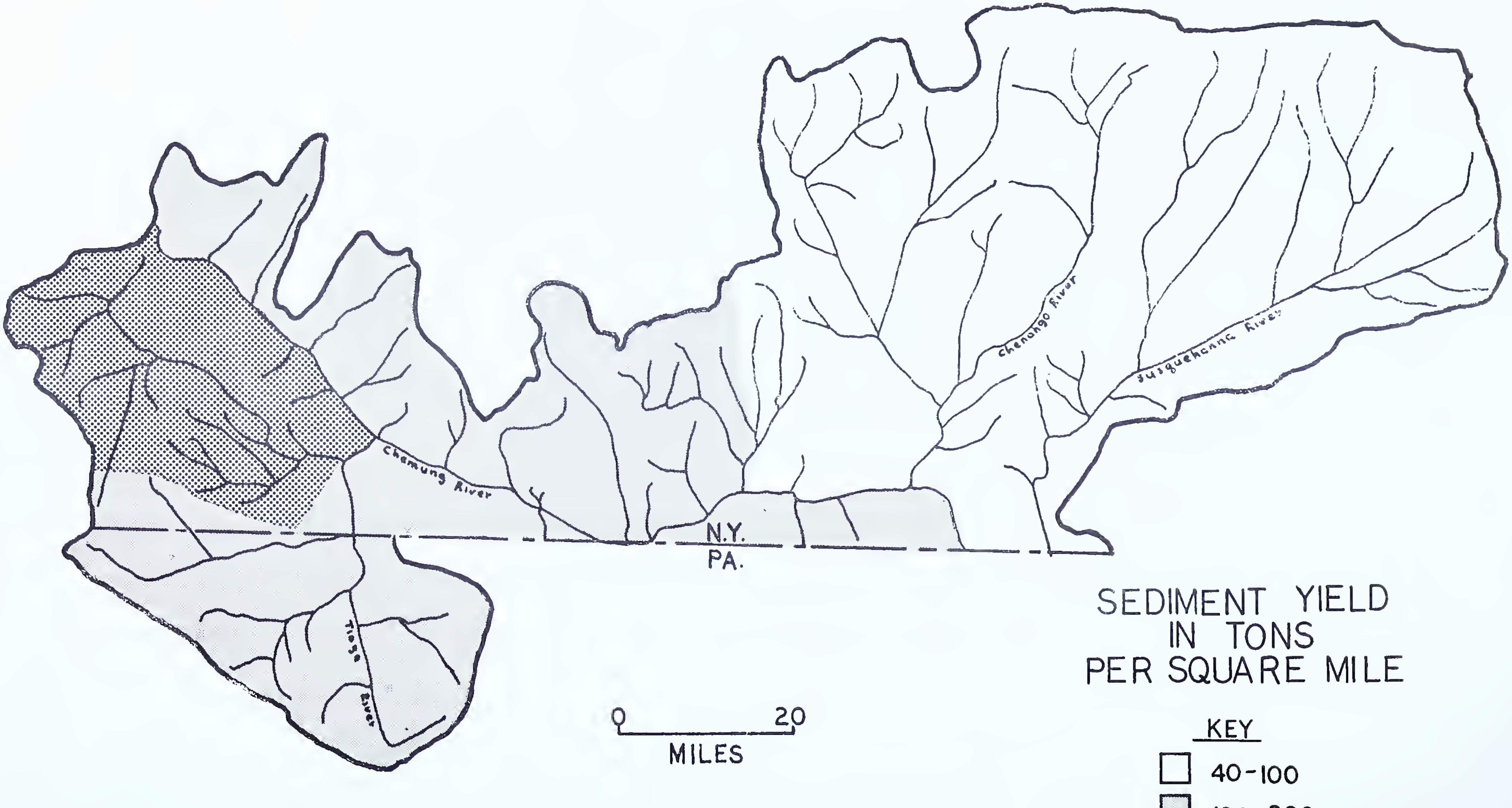

Figure 8 -- Average Annual Sediment Yields (Tons/Sq. Mi.) for Sampling Stations in the Chemung River and Susquehanna River Subbasins.

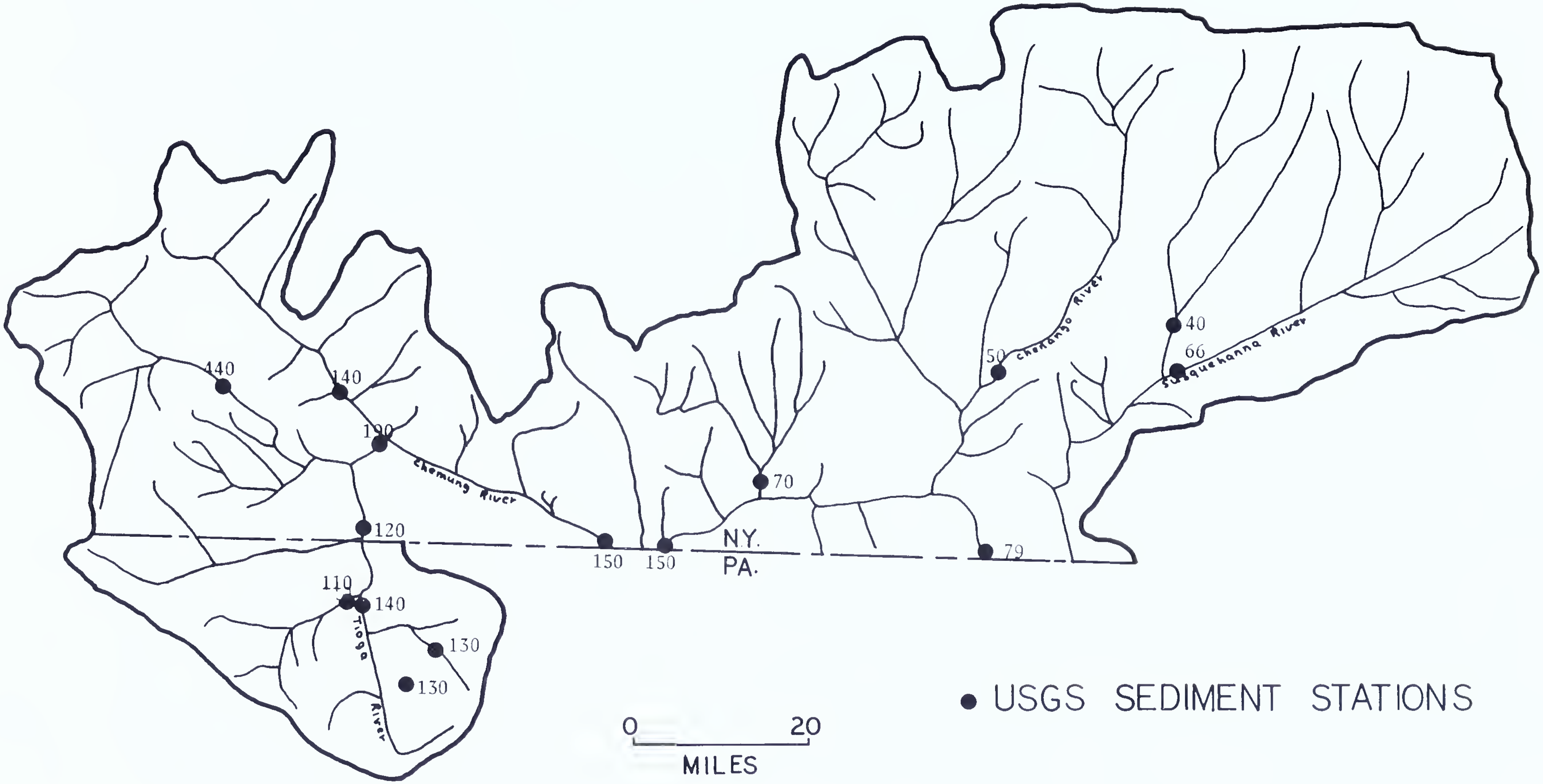

Figure 9 -- Average Annual Sediment Yield (Tons/Sq. Mi.) From the Chemung River and Susquehanna River Subbasins.

stations indicating significant nonpoint source contributions consist of approximately 45-48 percent agricultural land and 48-51 percent woodlands. The agricultural lands are generally located in the stream valleys, while the woodlands are located in the upland areas. Animal concentrations in Chemung averages 0.2 animals per acre of agricultural land and appears to be fairly evenly distributed. The topography in these areas to rugged with steep slopes. Commercial fertilizer and animal wastes from the agricultural lands are the probable source of NO_3-N. Topography and proximity of agricultural lands probably play an important role in the nutrient contribution into the streams from heavy runoff.

Literature suggests 0.3 mg/l of inorganic nitrogen (N) and 0.01 mg/l of phosphorus (P) as the critical values which, when exceeded, stimulate undesirable growth of algae (McKee & Wolf, 1963; Harms, Darnbush & Anderson, 1974). It has also been suggested that 0.05 mg/l or less of phosphorus would restrict noxious aquatic plant growths in flowing waters (Environmental Protection Agency, 1973).

Inorganic nitrogen concentrations (Table 4) in the Chemung River subbasin exceeded the critical nitrogen level of 0.3 mg/l by two to seven times at all stations during the higher flow periods and at Wheeler, Kanona, Campbell, Chemung and Hornellsville during the low flow period. Phosphorus concentrations exceeded the 0.01 - 0.05 mg/l critical values by three to over one hundred times at nearly all stations in the Chemung River subbasin during each of the flow periods. Although the inorganic nitrogen and phosphorus concentrations exceeded the critical levels of nutrients suggested in the literature, it does not necessarily indicate eutrophic conditions in these streams. Many other factors, such as time of year, velocity, depths, and types of streambed, influence the eutrophication process.

Data available for the Chemung subbasin indicates that the Cohocton River drainage area is the major contributor of NO_3-N, organic nitrogen and PO_4-P. This assumption is not conclusive because data for the Canisteo River is very limited; however, comparison of land use, topography and animal concentrations further support the assumption. Additional data is necessary for proper evaluation.

Susquehanna River Subbasin

Average nutrient concentrations for the Susquehanna River drainage area in New York are shown in Table 6. The highest concentration of NO_3-N was recorded at Owego (1.33 mg/l) during the moderate flow period. The table shows higher NO_3-N concentrations at each station during the higher flow periods, indicating greater influence from nonpoint sources. Generally, the data shows an increase in concentration downstream during each season.

Organic nitrogen and PO_4-P concentrations (Table 6) show

TABLE 6
AVERAGE NO_3-N, ORGANIC N AND PO_4-P CONCENTRATIONS FOR THE SUSQUEHANNA RIVER SUBBASIN, IN MILLIGRAMS PER LITRE

Station	Instantaneous Flow, cfs			NO_3-N			Org. N			PO_4-P		
	Jul.-Oct.	Nov.-Feb.	Mar.-Jun.	Jul.-Oct.	Nov.-Feb.	Mar.-Jun.	Jul.-Oct.	Nov.-Feb.	Mar.-Jun.	Jul.-Oct.	Nov.-Feb.	Mar.-Jun.
Susquehanna River at Unadilla	263	1228	2274	0.42	0.70	0.59	0.63	0.38	0.33	0.36	0.13	0.12
Susquehanna River at Bainbridge	536	3369	4573	0.44	0.69	0.67	0.64	0.49	0.50	0.25	0.24	0.16
Susquehanna River at Binghamton				0.22	0.45	0.41	0.25	0.34	0.17	0.23	0.16	0.27
Susquehanna River at Vestal	638	4284	8934	0.41	0.67	0.77	0.90	0.52	0.57	0.56	0.22	0.26
Susquehanna River at Owego				0.61	1.33	0.54	1.01	0.70	0.87	0.83	0.24	0.29
Susquehanna River at Smithboro	2136	11187	13832	0.54	0.65	0.87	0.82	0.54	0.60	0.57	0.33	0.26

that concentration decreased with increase in flows at each station, indicating that point sources are the primary contributor of organic nitrogen and PO4-P. Comparison of the average concentrations between stations for each of the flow periods show a general increase in organic nitrogen and PO_4-P concentrations downstream. The highest concentrations of organic nitrogen (1.01 mg/1) and PO4-P (0.83 mg/1) were recorded at Owego during the low flow period.

Regression analyses (Figures 10-13, Appendix) support the above hypotheses concerning the average concentrations shown in Table 6. The slopes of the regression equations for NO_3-N are all positive which indicate that nonpoint sources of nitrate have greater influence than point sources. The regression equation for NO_3-N at the Bainbridge station (Figure 10), which is downstream from Unadilla station and the confluence of the Unadilla River, shows a smaller positive slope than that for Unadilla station. This indicates that the Unadilla River drainage area has a lesser nonpoint source contribution than the drainage area above the station at Unadilla. The slope of the regression equation at Vestal is the greatest of the four stations on the Susquehanna River, indicating considerable nonpoint source contributions in the reach between Bainbridge and Vestal. Sufficient data is not available to separate the influence of the Chenango River drainage area from that of the reach above Vestal. The slope of the regression equation at Smithboro suggests a lesser influence from nonpoint sources.

Regression analyses for organic nitrogen and PO_4-P show a decrease in concentration as flows increase, suggesting that organic nitrogen and PO_4-P contributions are predominantly from point sources.

Loadings for each of the flow periods are shown in Table 7. The NO_3-N, organic nitrogen and PO_4-P loadings at each station increased with increasing flows. The loadings for all stations show an increase in the downstream direction for all flow periods, indicating substantial inputs from tributary watersheds.

The U.S. Geological Survey sediment study (Williams & Reed, 1972) included five stations in the Susquehanna River subbasin (Figure 8). The results of the study show an increase in sediment yields in the downstream direction.

Land use distribution is uniform in the Susquehanna River subbasin with approximately 33 percent in agriculture, 62 percent woodland and 2 percent urban. Animal concentrations average 0.5 animals per acre and are fairly uniformly distributed. There are no marked differences in topography within the Susquehanna River subbasin although there are slightly more of the steeper slopes upstream from the station at Bainbridge and in the Owego and Cayuta Creek drainage areas (See Plate 1). No significant observations could be made regarding relationships between NO_3-N, organic nitrogen and PO_4-P data, land use, topography and animal concentrations in the Susquehanna River drainage area.

TABLE 7
AVERAGE NO_3-N, ORGANIC N AND PO_4-P LOADINGS FOR THE SUSQUEHANNA RIVER SUBBASIN, IN POUNDS PER DAY

Station	Instantaneous Flow, cfs			NO_3-N			Org. N			PO_4-P		
	Jul.-Oct.	Nov.-Feb.	Mar.-Jun.	Jul.-Oct.	Nov.-Feb.	Mar.-Jun.	Jul.-Oct.	Nov.-Feb.	Mar.-Jun.	Jul.-Oct.	Nov.-Feb.	Mar.-Jun.
Susquehanna River at Unadilla	263	1228	2274	609	5514	9696	893	2315	4045	478	691	1766
Susquehanna River at Bainbridge	536	3369	4573	1171	12336	17030	1849	8398	12324	711	4565	5088
Susquehanna River at Vestal	638	4284	8954	4712	37609	43583	3095	12007	27448	6160	10164	11011
Susquehanna River at Smithboro	2136	11187	13852	6136	38058	70952	9441	32561	44735	6199	20596	18851

Inorganic nitrogen concentrations in the Susquehanna River drainage area (Table 6) exceeded the critical level of 0.3 mg/l by nearly 1.5 - four times at all stations during each flow period. PO_4-P concentrations also exceeded the critical values of 0.01 - 0.05 mg/l by two to eighty times at all stations during each of the flow periods.

The mean concentrations of NO_3-N, organic nitrogen and PO_4-P in the Chenango River drainage area, consisting of the Chenango River, Tioughnioga River and the Otselic River, are shown in Table 8. The monitoring station at Blodgett Mills on the Tioughnioga River recorded the highest NO_3-N concentrations (1.60, 1.40 and 1.81 mg/l) in the Chenango River drainage area for all three flow periods. Monitoring stations at Sherburne and Norwich in the upper reaches of the Chenango River also recorded high NO_3-N concentrations (1.06 mg/l at both stations) during the higher flow periods. The seasonal averages indicated that NO_3-N concentrations generally increased with higher flows at each station and that concentrations decreased downstream during each season.

The highest concentrations of organic nitrogen (0.72 mg/l) and PO_4-P (0.74 mg/l) occurred at Blodgett Mills during the low flow period. Seasonal averages indicate that organic nitrogen and PO_4-P concentrations generally decrease with increased flows. Organic nitrogen data for Smithville Flats and Chenango Forks show a slight increase during the moderate flow period and then a decrease during the high flow period.

TABLE 8
AVERAGE NO_3-N, ORGANIC N AND PO_4-P CONCENTRATIONS FOR THE CHENANGO RIVER DRAINAGE AREA, IN MILLIGRAMS PER LITRE

Station	Instantaneous Flow, cfs			NO_3-N			Org. N			PO_4-P		
	Jul.-Oct.	Nov.-Feb.	Mar.-Jun.	Jul.-Oct.	Nov.-Feb.	Mar.-Jun.	Jul.-Oct.	Nov.-Feb.	Mar.-Jun.	Jul.-Oct.	Nov.-Feb.	Mar.-Jun.
Chenango River at Sherburne	76	333	574	0.95	0.94	1.06	0.50	0.44	0.43	0.16	0.14	0.21
Chenango River at Norwich				0.68	1.06	0.86	0.65	0.59	0.68	0.54	0.31	0.28
Genegantslet Crk. at Smithville Flats	20	117	205	0.63	0.87	0.81	0.11	0.13	0.11	0.07	0.06	0.05
Chenango River at Chenango Forks	469	2118	3465	0.34	0.61	0.61	0.47	0.65	0.29	0.49	0.27	0.30
Tioughnioga River at Blodgett Mills	212	660	1040	1.60	1.40	1.81	0.72	0.59	0.48	0.74	0.19	0.25
Tioughnioga River at Itaska	171	932	1777	0.63	0.85	0.79	0.22	0.58	0.24	0.54	0.25	0.26
Chenango River at Chenango Bridge				0.28	0.72	0.59	0.32	0.50	0.21	0.46	0.27	0.31

Regression analyses for concentration and flow relationships (Figures 14-18, Appendix) generally support the indications of the seasonal averages that nitrate concentrations increase with increased flows. The data does not show marked differences in the magnitude of increase at each station, although land use and topography differ significantly.

Regression analyses of organic nitrogen data, shown in Figures 14-18, also indicate general agreement in the tendency for organic nitrogen to decrease as flows increase. Exceptions to this were noted at Smithville Flats and Chenango Forks where the data indicate an increase in concentration as flows increase. Apparently, nonpoint sources are significant contributors of organic nitrogen in these areas.

Regression analyses for PO_4-P (Figures 14-18) show that PO4-P concentrations decrease with increased flows at all stations.

Average loadings for each of the flow periods are shown in Table 9. Generally, the NO_3-N, organic nitrogen and PO_4-P loadings at each sampling station increase with increased flows. The table shows that the Chenango River at Chenango Forks above its confluence with the Tioughnioga River has the highest loadings for NO_3-N, organic nitrogen and PO_4-P within the drainage area. Nitrate loadings at Blodgett Mills suggest substantial NO_3-N input from that watershed. Loadings for the low flow period at Blodgett Mills exceeded that of Chenango

TABLE 9
AVERAGE NO_3-N, ORGANIC N AND PO_4-P LOADINGS FOR THE CHENANGO RIVER DRAINAGE AREA, IN POUNDS PER DAY

Station	Instantaneous Flow, cfs			NO_3-N			Org. N			PO_4-P		
	Jul.-Oct.	Nov.-Feb.	Mar.-Jun.	Jul.-Oct.	Nov.-Feb.	Mar.-Jun.	Jul.-Oct.	Nov.-Feb.	Mar.-Jun.	Jul.-Oct.	Nov.-Feb.	Mar.-Jun.
Chenango River at Sherburne	76	333	574	467	2081	3268	205	790	1330	83	301	575
Genegantslet Creek at Smithville Flats	20	117	205	106	466	1103	12	82	122	9	36	60
Chenango River at Chenango Forks	469	2118	3465	808	10434	11167	1188	7420	5416	964	4990	5162
Tioughnioga River at Blodgett Mills	212	660	1040	1809	5040	10498	823	2099	2691	738	687	1607
Tioughnioga River at Itaska	171	932	1777	582	8196	8314	203	2914	2239	462	2394	2655

Forks, which has a larger drainage area, and nearly equalled the loading during the high flow period.

The U.S. Geological Survey sediment study (Williams & Reed, 1972) included one station at Greene, New York, in the Chenango River drainage area (Figure 8).

Land use and slope in the Chenango River drainage area varies somewhat. The Tioughnioga River drains an area that has steeper slopes (Plate 1) than the Chenango River upstream of Chenango Forks. Major land uses in the Tioughnioga River drainage area are comprised of approximately 55 percent woodland and 42 percent agricultural lands while the Chenango River drainage area upstream of Chenango Forks is comprised of approximately 60 percent woodland and 34 percent agricultural land. Regression analyses of data collected at Itaska on the Tioughnioga River and at Chenango Forks on the Chenango River indicate that the Chenango River upstream from Chenango Forks with a flatter terrain and greater area in woodlands is influenced slightly more by nonpoint sources of NO_3-N than the Tioughnioga River. Comparison of the results of regression analyses at Smithville Flats on the Genegantslet Creek and Blodgett Mills on the upper reaches of the Tioughnioga River also indicates that the Genegantslet Creek upstream of Smithville Flats is influenced slightly more by nonpoint sources of NO_3-N than the Tioughnioga River at Blodgett Mills. The drainage area upstream of Smithville Flats has a flatter terrain and is comprised of about 76 percent woodland, while the area upstream of Blodgett Mills has a more rugged terrain and is comprised of about 45 percent agricultural land and 50 percent woodland.

The reason for the indication that nonpoint sources of NO_3-N have a greater influence in areas with flatter terrain and predominantly woodlands in the Chenango River drainage area is not known. Additional data need to be collected to verify the results of this analysis.

The critical inorganic nitrogen concentration for stimulation of algal growth (0.3 mg/l) was exceeded by two to six times at all stations in the Chenango River drainage area during the higher flow periods. Inorganic nitrogen concentrations (Table 8) during the low flow period also exceeded the critical value by two to five times at nearly all stations. Phosphorus concentrations exceeded the critical concentration (0.01 - 0.05 mg/l) at all stations during each flow period. The phosphorus concentrations were three to seventy times higher than the critical value at all stations except Smithville Flats.

COMPARISON OF CHEMUNG AND SUSQUEHANNA RIVER SUBBASINS

Analyses of concentration-flow relationship for the Chemung River and Susquehanna River subbasins indicate that nonpoint source contributions of NO_3-N are evident at all sampling stations. The slopes of the regression equations are very similar for all stations in both subbasins, with slightly greater slopes noted in the Chemung River subbasin. The greater slopes suggest a greater influence from nonpoint sources. Within the Susquehanna River subbasin, the analyses suggest that the Susquehanna River drainage area above Binghamton has a greater nonpoint source NO_3-N contribution than the Chenango River drainage area.

Analyses for organic nitrogen concentrations indicate that nonpoint sources of organic nitrogen have a greater influence than point sources at all stations in the Chemung River subbasin. Results for the Susquehanna River subbasin indicate that point sources of organic nitrogen are the primary sources at nearly all stations. The analyses at two stations, Smithville Flats and Chenango Forks in the Chenango River drainage area, indicate that nonpoint sources of organic nitrogen have a greater influence than point sources.

Analyses of data from monitoring stations at Wheeler and Kanona in the Chemung River subbasin indicate significant contributions of PO_4-P from nonpoint sources, while there were no indications of major nonpoint source influence at any of the stations in the Susquehanna River subbasin.

Available data for 1972 concerning loadings from municipal sewage treatment plants upstream of each sampling station and the average stream loadings are shown in Table 10. Data for industrial discharges were not available.

When comparing the point source loadings with the stream loadings it can be seen that the point source loadings were only a small part of the stream loadings during the higher flow periods at all stations in the Chemung River and Susquehanna River subbasins, which indicates sizeable inputs from nonpoint sources.

Although the regression analyses for flow-concentration relationships suggest greater influence from nonpoint sources in the Chemung River subbasin, the average loadings of NO_3-N, organic nitrogen and PO_4-P at Chemung and Smithboro near the New York-Pennsylvania border show that the Susquehanna River subbasin has considerably higher nonpoint source loadings than the Chemung River subbasin due to the larger flows in the Susquehanna River subbasin.

Table 11 shows the loadings at 15 stations in the Chemung and Susquehanna River subbasins in pounds-per-day-per-square mile. The point source loads were deducted from the total stream load; therefore, the loads would reflect nonpoint source loads. The

TABLE 10

AVERAGE STREAM LOADINGS AND 1972 POINT SOURCE LOADINGS FROM MUNICIPAL SEWAGE TREATMENT PLANTS, IN POUNDS PER DAY

Station & Subbasin	Stream Loading						Point Source Loads		Number of Treatment Plants Between Sampling Stations
	Nitrogen			Phosphorus					
	Jul.-Oct.	Nov.-Feb.	Mar.-Jun.	Jul.-Oct.	Nov.-Feb.	Mar.-Jun.	Total Nitrogen	Total Phosphorus	
Susquehanna River Subbasin									
Susquehanna R. at Unadilla	1502	8029	13741	478	691	1766	214	No data	2
Susquehanna R. at Bainbridge	3020	21234	29354	711	4565	3088	221	17	2
Susquehanna R. at Vestal	7807	49616	71031	6160	10164	11011	6282	1686	3
Susquehanna R. at Smithboro	15577	70619	115685	6199	20596	18851	6801	1707	4
Chenango R. at Sherburne	672	2871	4596	83	301	575	60	42	2
Genegantslet Crk. at Smithville Flats	118	548	1225	9	36	60	No data	No data	0
Chenango R. at Chenango Forks	1996	17854	16583	964	1990	5182	405	135	2
Tioughnioga R. at Blodgett Mills	2632	7139	13189	738	687	1607	834	1	2
Tioughnioga R. at Itaska	785	11110	10613	462	2394	2633	834	1	0
Chemung River Subbasin									
Five Mile Crk. at Wheeler	54	365	2531	11	42	598	No data	No data	

TABLE 10
(Cont'd)

Station & Subbasin	Stream Loading						Point Source Loads		Number of Treatment Plants Between Sampling Stations
	Nitrogen			Phosphorus					
	Jul.-Oct.	Nov.-Feb.	Mar.-Jun.	Jul.-Oct.	Nov.-Feb.	Mar.-Jun.	Total Nitrogen	Total Phosphorus	
Five Mile Crk. at Kanona	46	457	1437	9	70	484	No data	No data	
Cohocton R. at Campbell	763	4289	5843	140	353	917	No data	No data	1
Tioga R. at Lindley	351	2930	5981	156	512	1037	No data	No data	
Chemung R. at Chemung	4160	14953	38496	4314	5333	12062	1987	No data	8 (data available for 7)

AVERAGE TOTAL NITROGEN AND PHOSPHATE LOADINGS FOR THE CHEMUNG AND SUSQUEHANNA RIVER SUBBASINS
(Lbs./Day/Sq. Mi.)

	Total Nitrogen			PO_4		
	Jul.-Oct. Low Flow	Nov.-Feb. Mod. Flow	Mar.-Jun. High Flow	Jul.-Oct. Low Flow	Nov.-Feb. Mod. Flow	Mar.-Jun. High Flow
Unadilla	1.31	7.94	13.75	0.49	0.70	1.80
Bainbridge	1.73	12.97	17.98	0.43	2.68	1.89
Vestal	0.38	10.94	16.35	1.13	2.14	2.35
Smithboro	1.84	13.38	22.82	0.94	3.96	3.59
Sherburne	2.32	10.65	17.19	0.15	0.98	2.01
Smithville Flats	0.14	0.66	1.47	0.10	0.43	0.716
Chenango Forks	1.07	11.69	10.84	0.55	3.25	3.38
Blodgett Mills	5.17	18.12	35.50	2.12	1.97	4.62
Itaska	*	13.98	13.30	0.63	4.34	3.58
Wheeler	0.90	6.08	42.18	0.18	0.70	9.97
Kanona	0.77	7.62	23.95	0.15	0.70	8.06
Campbell	1.62	9.09	12.38	0.67	0.48	1.94
Lindley	0.45	3.80	7.77	0.21	0.66	1.35
Chemung	0.86	5.12	14.43	1.71	2.11	4.77

* Point source load higher than stream load.

greatest loadings of nitrogen and PO_4-P in the Chemung River subbasin were found at Wheeler and Kanona. These loadings, as shown in Table 11, were higher than most of the loadings in the Susquehanna River subbasin. In general, comparison of the loadings in both subbasins indicates that the Susquehanna River subbasin has a higher loading per square mile than the Chemung River subbasin. Within the Susquehanna River subbasin, the Chenango River drainage area appears to have the heavier loadings per square mile.

The results of the U.S. Geological Survey sediment study (Williams & Reed, 1972) show that the Chemung River subbasin has considerably higher sediment yields than the Susquehanna River subbasin.

CONCLUSIONS

Regression analyses for concentration-flow relationships indicate that NO_3-N concentrations increase with increased flows.

Generally, maximum concentrations of PO_4-P occurred during the low flow period with a decrease in concentration during the higher flow periods. Exceptions were noted at Wheeler and Kanona in the Chemung River subbasin where maximum concentrations occurred during the high flow period.

In the Chemung River subbasin, analyses of data resulted in positive slopes in the regression equations for NO_3-N, organic nitrogen and PO_4-P, suggesting greater nonpoint source pollution in the Cohocton River than in the remainder of the subbasin. The loads in pounds-per-day-per-square mile also show that the Cohocton River subbasin has the greatest loadings on a per-square-mile basis within the Chemung River subbasin. Maximum organic nitrogen concentrations in the Chemung River subbasin occurred during the high flow period; while in the Susquehanna River subbasin, maximum concentrations of organic nitrogen generally occurred during the low flow period. Exceptions were noted at Smithville Flats, Chenango Forks and Itaska, New York, where higher concentrations occurred at higher flow periods.

Average loadings of NO_3-N, organic nitrogen and PO_4-P near the New York-Pennsylvania border show that the Susquehanna River has considerably higher nutrient loadings than the Chemung River. Available point source loading data for total nitrogen and total phosphorus show that the stream loads were considerably higher than the point source loads, indicating that nonpoint sources are the major contributor of nutrients.

Nutrient loadings in pounds-per-day-per-square mile for the Susquehanna River subbasin suggests that nonpoint sources in the Chenango River drainage area provide a greater contribution of nutrients than the remainder of the subbasin.

The U.S. Geological Survey appraisal of stream sedimentation in the Susquehanna River Basin shows that the Chemung River subbasin has greater sediment loads than the Susquehanna River subbasin.

Additional data collection is necessary to verify the findings in this study. Data available for this appraisal of nonpoint source impacts imposed many restrictions. The data were results of analyses of grab samples which do not necessarily reflect the conditions of the cross section of the sampling site. Initial inventory of stream gaging stations and water quality monitoring stations suggested that data would be plentiful; however, this was not the case in many instances. Also, the type of data collected varied at each station.

A summary of nutrient and flow data analyzed, based on the percent of monthly grab samples available for analysis, is shown in Table 12 for each monthly sampling station. Usually, concentrations of the various parameters were plentiful, but little or no flow data was available. The quantity of data at each monthly sampling station varied from four samples to sixty samples. Data for Canisteo River in the Chemung River subbasin was grossly inadequate. Locations of sampling stations also restricted the evaluation. Attempts to quantify nonpoint source loads according to land use by estimating contributions from typical watersheds could not be accomplished because water quality data was not available for watersheds where one type of land use (i.e. agricultural land) was dominant.

Point source load data used in this study was incomplete. An inventory of municipal and industrial discharges listed the locations, but in many instances flow and effluent quality was not shown.

Interagency coordination for water quality data collection appears to be inadequate. Data available for this study demonstrated the variations in the amount and type of data collected.

There is a need for developing some guidelines which provide a range of nutrient concentrations or nitrogen - phosphorus ratios in healthy streams within the Susquehanna River Basin. These guidelines will then provide a basis for comparison of streams and estimation of severity of nutrient pollution.

TABLE 12

SUMMARY OF NUTRIENT AND FLOW DATA ANALYZED

Chemung River Subbasin

Monthly Sampling Stations	Period of Available Data In Months Prior to September 1972	Nutrient Samples Available for Analysis, In Percent of Potential Monthly Samples	Flow Measurements Available for Analysis, In Percent of Potential Monthly Measurements
Five Mile Crk. at Wheeler	42	100	45
Five Mile Crk. at Kanona	60	88	85
Cohocton R. at Campbell	57	88	74
Canisteo R. at Hornellsville	48	79	12
Tioga R. at Lindley	55	84	74
Chemung R. at Corning	48	73	0
Chemung R. at Big Flats	60	93	17
Chemung R. at Chemung	57	91	82

Susquehanna River Subbasin

Monthly Sampling Stations	Period of Available Data In Months Prior to September 1972	Nutrient Samples Available for Analysis, In Percent of Potential Monthly Samples	Flow Measurements Available for Analysis, In Percent of Potential Monthly Measurements
Susquehanna R. at Unadilla	24	100	100
Susquehanna R. at Bainbridge	48	100	83
Susquehanna R. at Binghamton	72[a]	36	4
Susquehanna R. at Vestal	57	93	67
Susquehanna R. at Owego	18	100	0
Susquehanna R. at Smithboro	57	95	84
Chenango R. at Sherburne	48	90	90
Chenango R. at Norwich	48	90	8
Tioughnioga R. at Blodgett Mills	48	100	90
Tioughnioga R. at Itaska	32[b]	69	56

a - Record to August 1970
b - Record to August 1968

TABLE 12

(Cont'd)

Monthly Sampling Stations	Period of Available Data In Months Prior to September 1972	Nutrient Samples Available for Analysis, In Percent of Potential Monthly Samples	Flow Measurements Available for Analysis, In Percent of Potential Monthly Measurements
Genegantslet Crk. at Smithville Flats	51[c]	47	47
Chenango R. at Chenango Forks	33[d]	64	58
Chenango R. at Chenango Bridge	23[e]	74	0

c - Record to September 1970
d - Record to September 1968

RECOMMENDATIONS

It is recommended that:

1. Additional data collection be initiated in both the Chemung River and Susquehanna River subbasins to verify the findings of this study. A special effort should be made to include the Canisteo River and Tioga River upstream of Lindley, New York, in the Chemung River subbasin, and the Unadilla River in the Susquehanna River subbasin.

2. Water quality data collection agencies coordinate their efforts to develop a sampling network to provide uniformity in the type of data collected and frequency of samplings, and to eliminate data gaps. The network should provide sufficient data to assist any agency in making an assessment of problem areas similar to that which was attempted in this study.

3. A study be initiated to develop some guidelines which provide a range to nutrient concentrations of nitrogen - phosphorus ratios in healthy streams within the Susquehanna River Basin.

4. Long term monitoring programs be developed to quantify nonpoint source nutrient loadings from watersheds with specific land uses, to determine relationships between nutrient loadings and sediment yields, and to evaluate the impact of nonpoint source pollution on the health of the streams.

BIBLIOGRAPHY

1. Clark, L. J., Guide, V. and Pheiffer, T. H., 1974, Nutrient Transport and Accountability in the Lower Susquehanna River Basin, Summary and Conclusions, Annapolis Field Office, Region III, Environmental Protection Agency, Technical Report 60, 91 p.

2. Environmental Protection Agency, 1973, Water Quality Criteria, Report of the Committee on Water Quality Criteria, EPA-R3-73-033, p. 81.

3. Harms, L. L., Darnbush, J. N., and Anderson, J. R., 1974, Physical and Chemical Quality of Agricultural Land Runoff, Journal Water Pollution Control Federation, Vol. 46, No. 11, p. 2,460.

4. McKee, J. E. and Wolf, H. W., 1963, Water Quality Criteria, The Resources Agency of California, State Water Quality Control Board, Pub. No. 3-A, p. 300.

5. Williams, K. F. and Reed, L. A., 1972, Appraisal of Stream Sedimentation in the Susquehanna River Basin, Geological Survey Water Supply Paper 1532-F, 24 p.

6. Susquehanna River Basin Study Coordinating Committee, 1970, Susquehanna River Basin Study, Appendix C, Economics and Geography.

APPENDIX

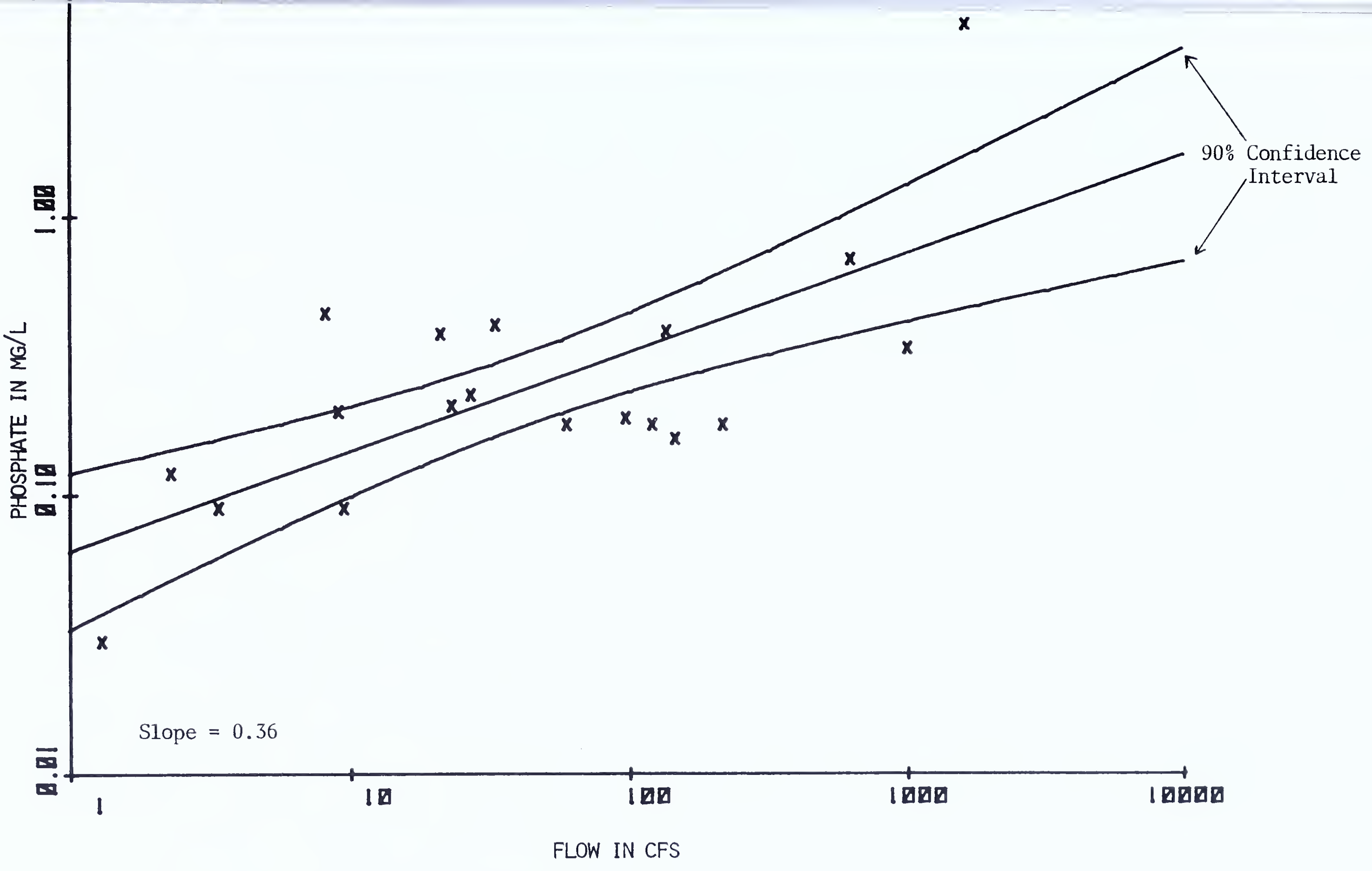

FIGURE 3A -- GRAPH SHOWING REGRESSION LINE FOR PHOSPHATE AGAINST THE FLOW IN FIVE MILE CREEK AT WHEELER, NEW YORK.

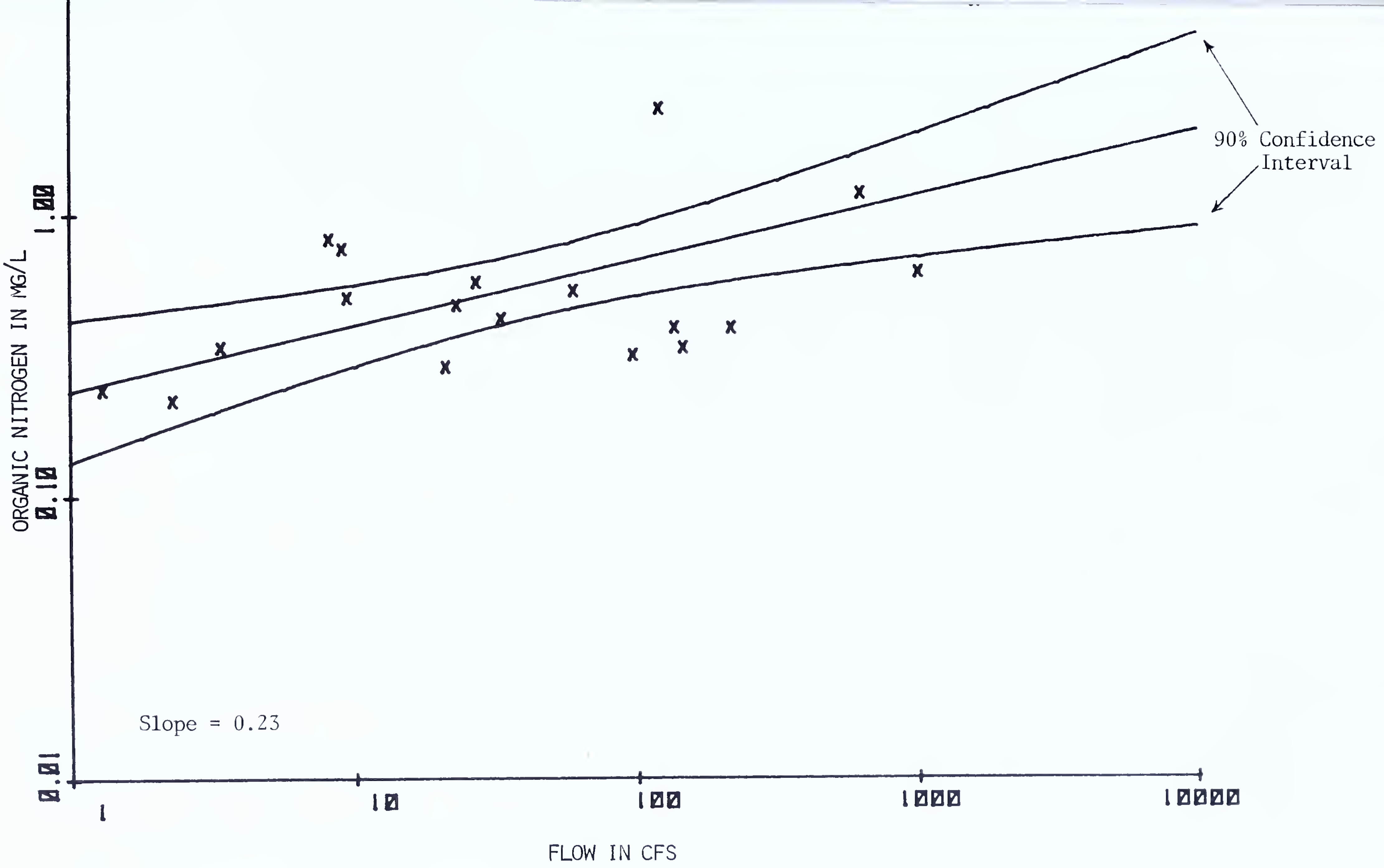

FIGURE 3B -- GRAPH SHOWING REGRESSION LINE FOR ORGANIC NITROGEN AGAINST THE FLOW IN FIVE MILE CREEK AT WHEELER, NEW YORK.

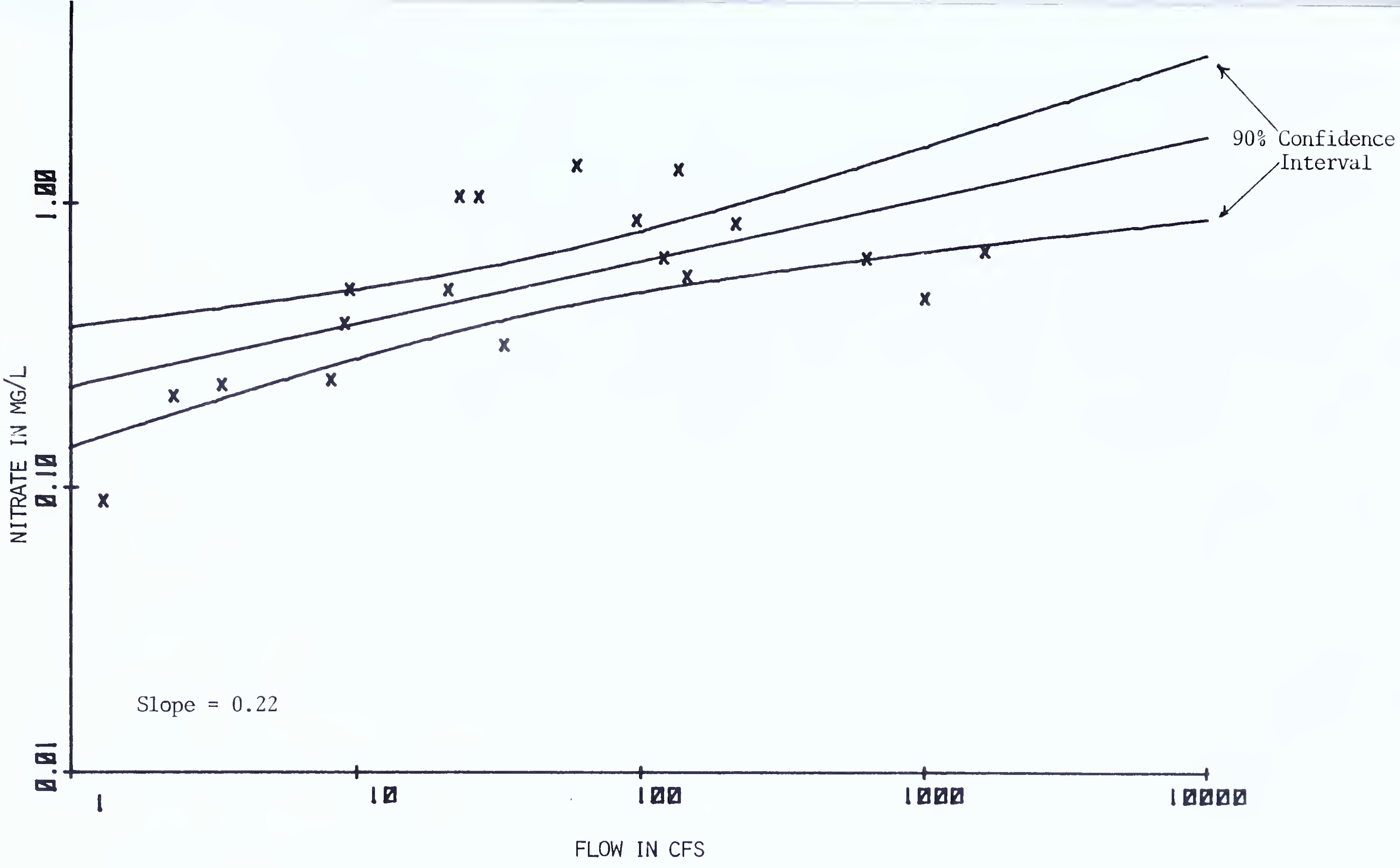

FIGURE 3C -- GRAPH SHOWING REGRESSION LINE FOR NITRATE AGAINST THE FLOW IN FIVE MILE CREEK AT WHEELER, NEW YORK.

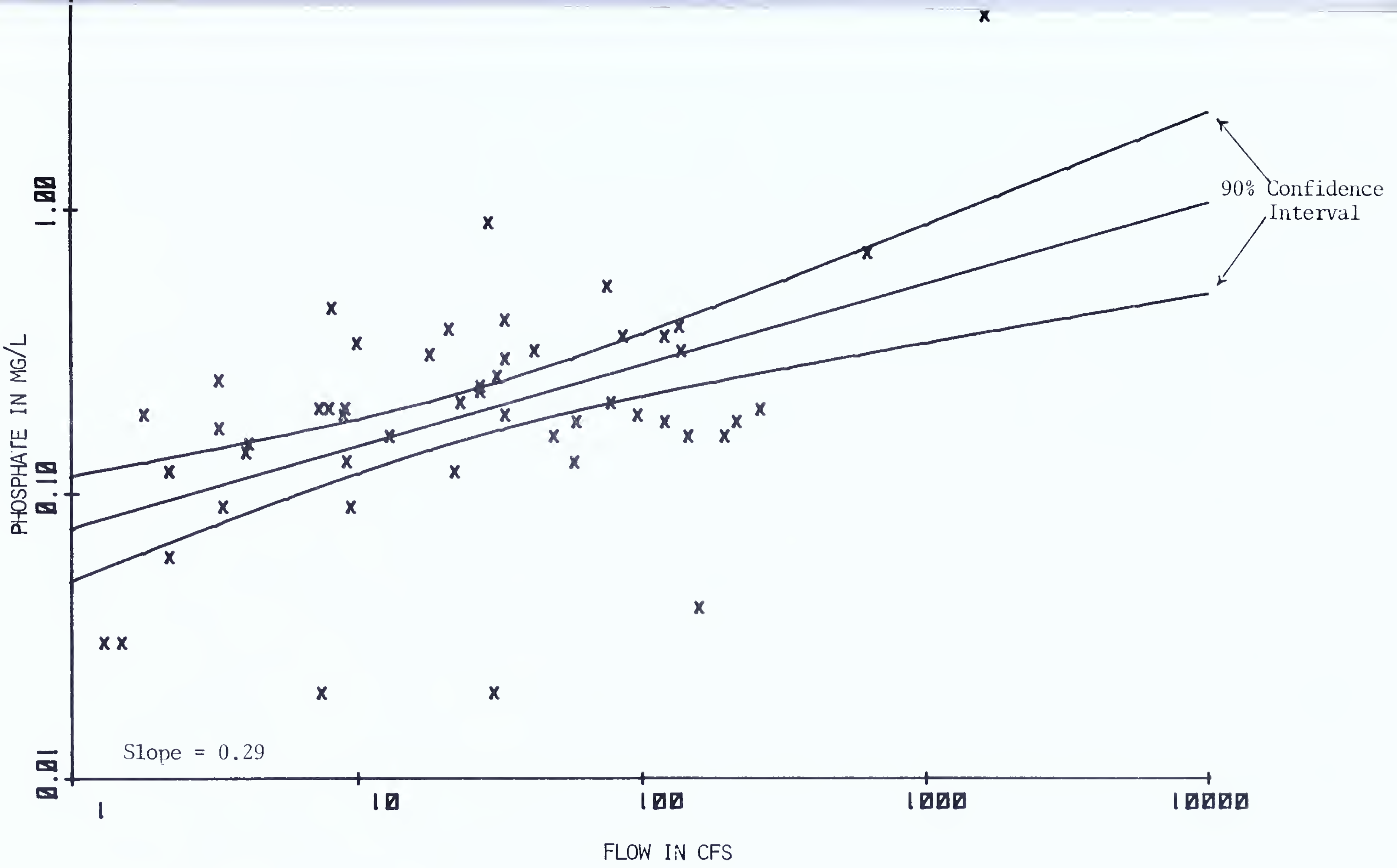

FIGURE 4A -- GRAPH SHOWING REGRESSION LINE FOR PHOSPHATE AGAINST THE FLOW IN FIVE MILE CREEK AT KANONA, NEW YORK.

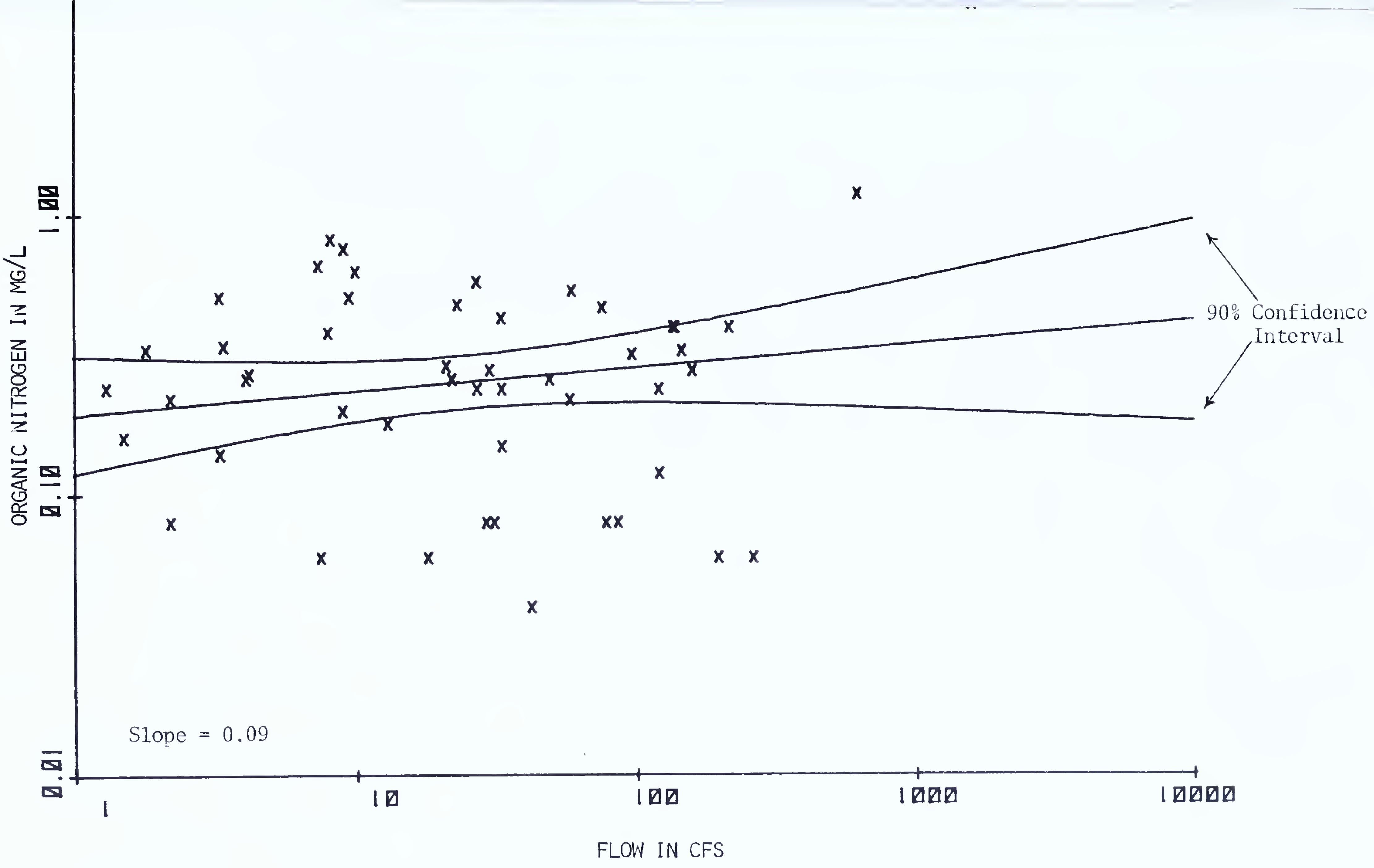

FIGURE 4B -- GRAPH SHOWING REGRESSION LINE FOR ORGANIC NITROGEN AGAINST THE FLOW IN FIVE MILE CREEK AT KANONA, NEW YORK.

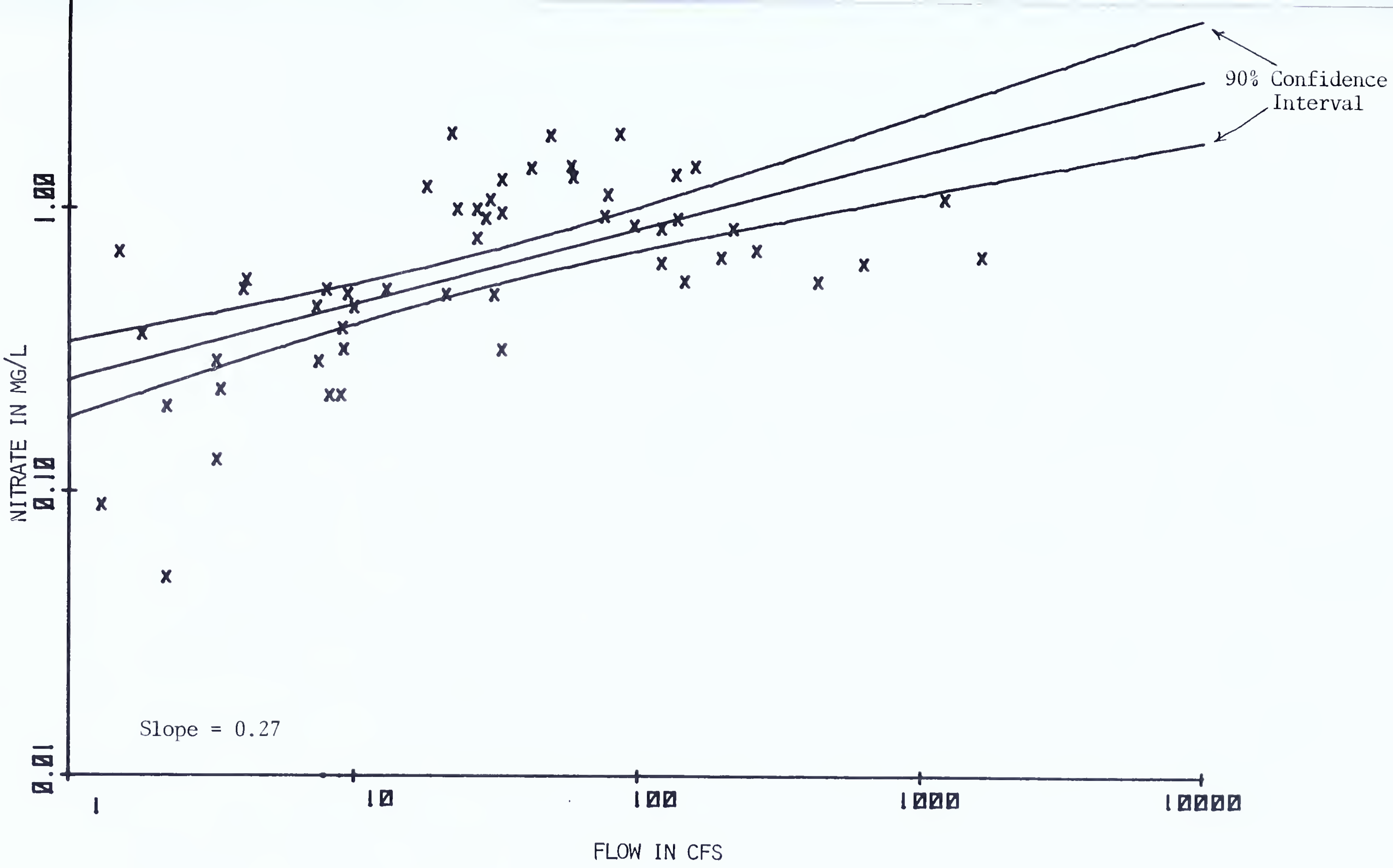

FIGURE 4C -- GRAPH SHOWING REGRESSION LINE FOR NITRATE AGAINST THE FLOW IN FIVE MILE CREEK AT KANONA, NEW YORK.

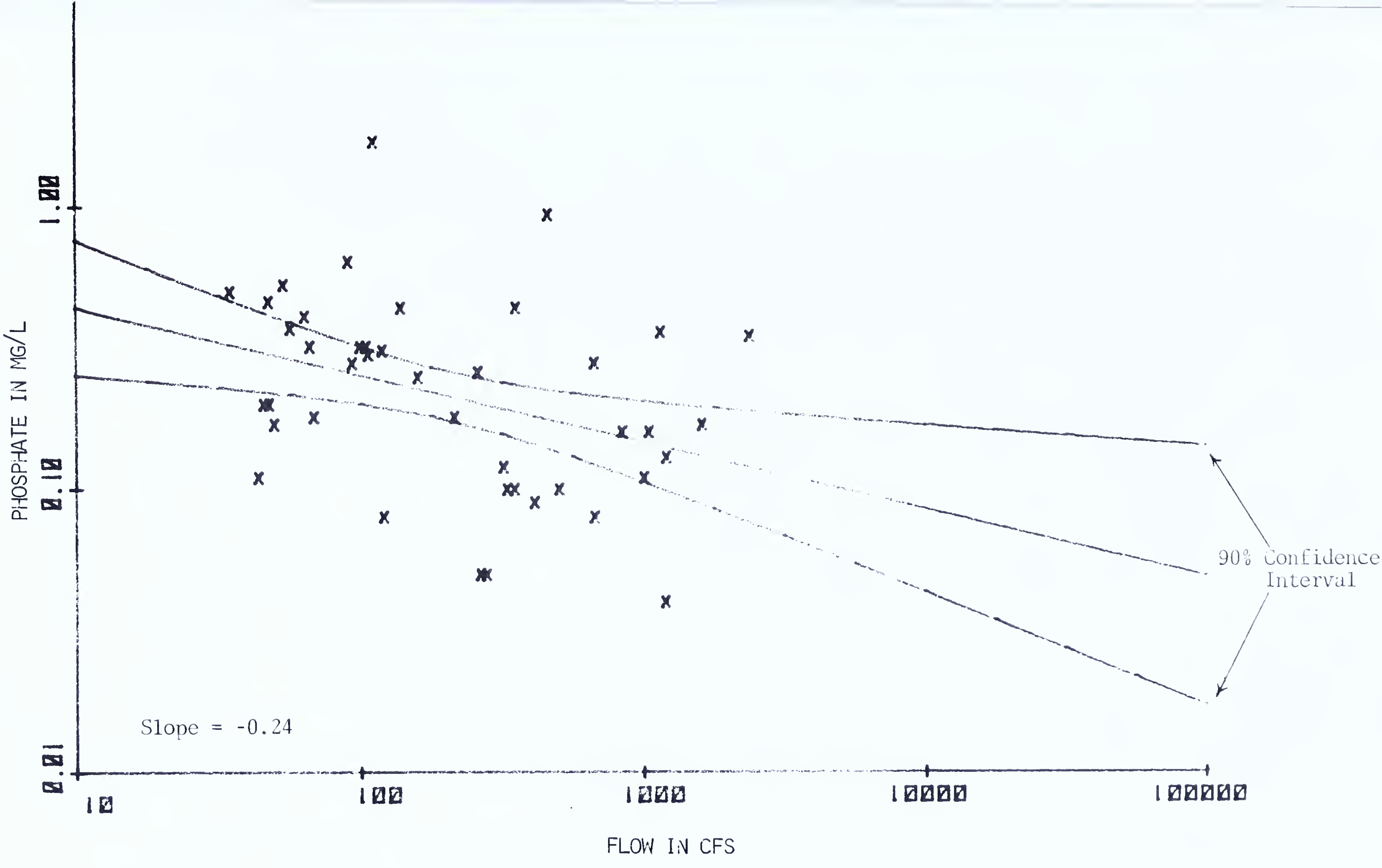

FIGURE 5A -- GRAPH SHOWING REGRESSION LINE FOR PHOSPHATE AGAINST THE FLOW IN COHOCTON RIVER AT CAMPBELL, NEW YORK.

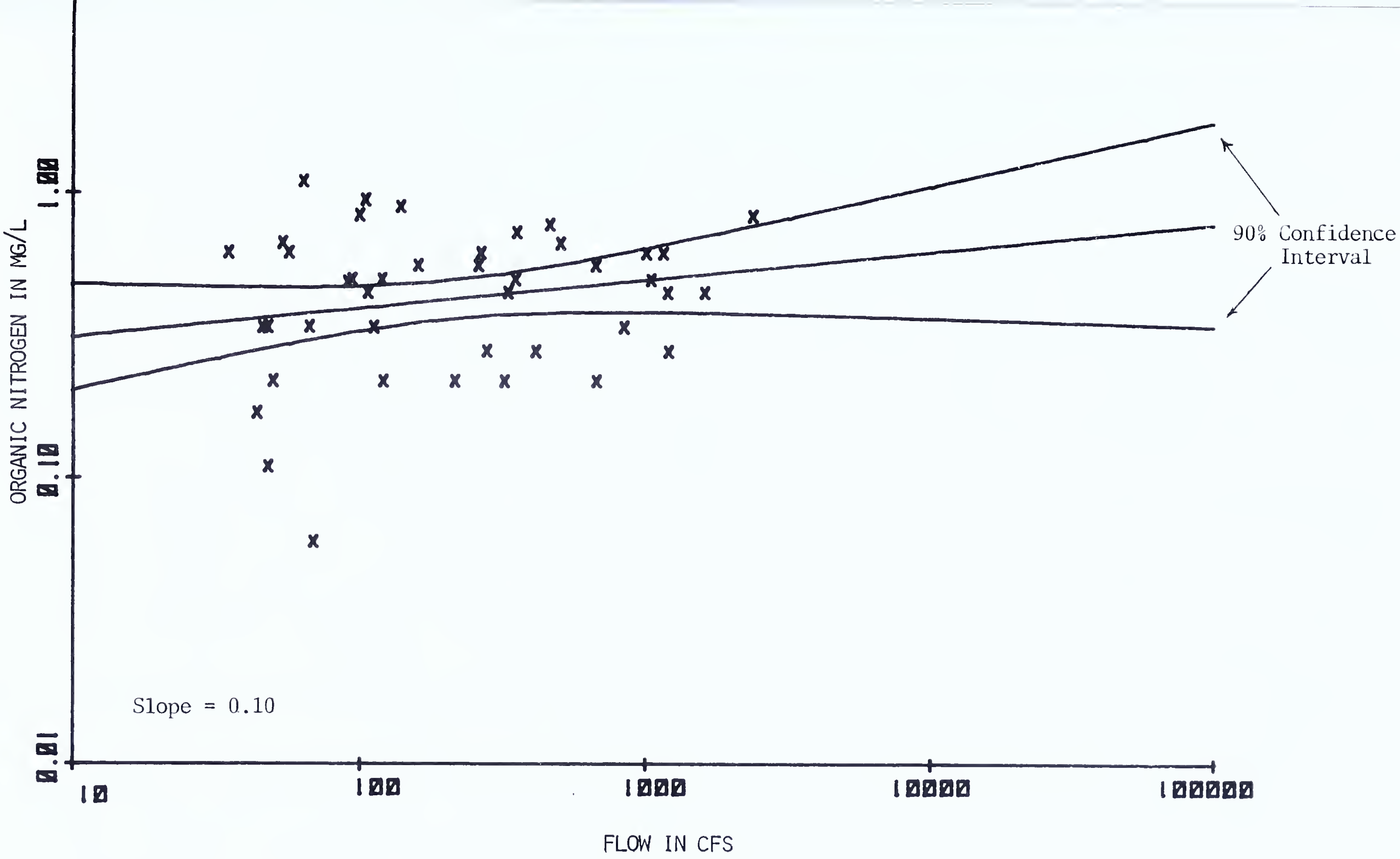

FIGURE 5B -- GRAPH SHOWING REGRESSION LINE FOR ORGANIC NITROGEN AGAINST THE FLOW IN COHOCTON RIVER AT CAMPBELL, NEW YORK.

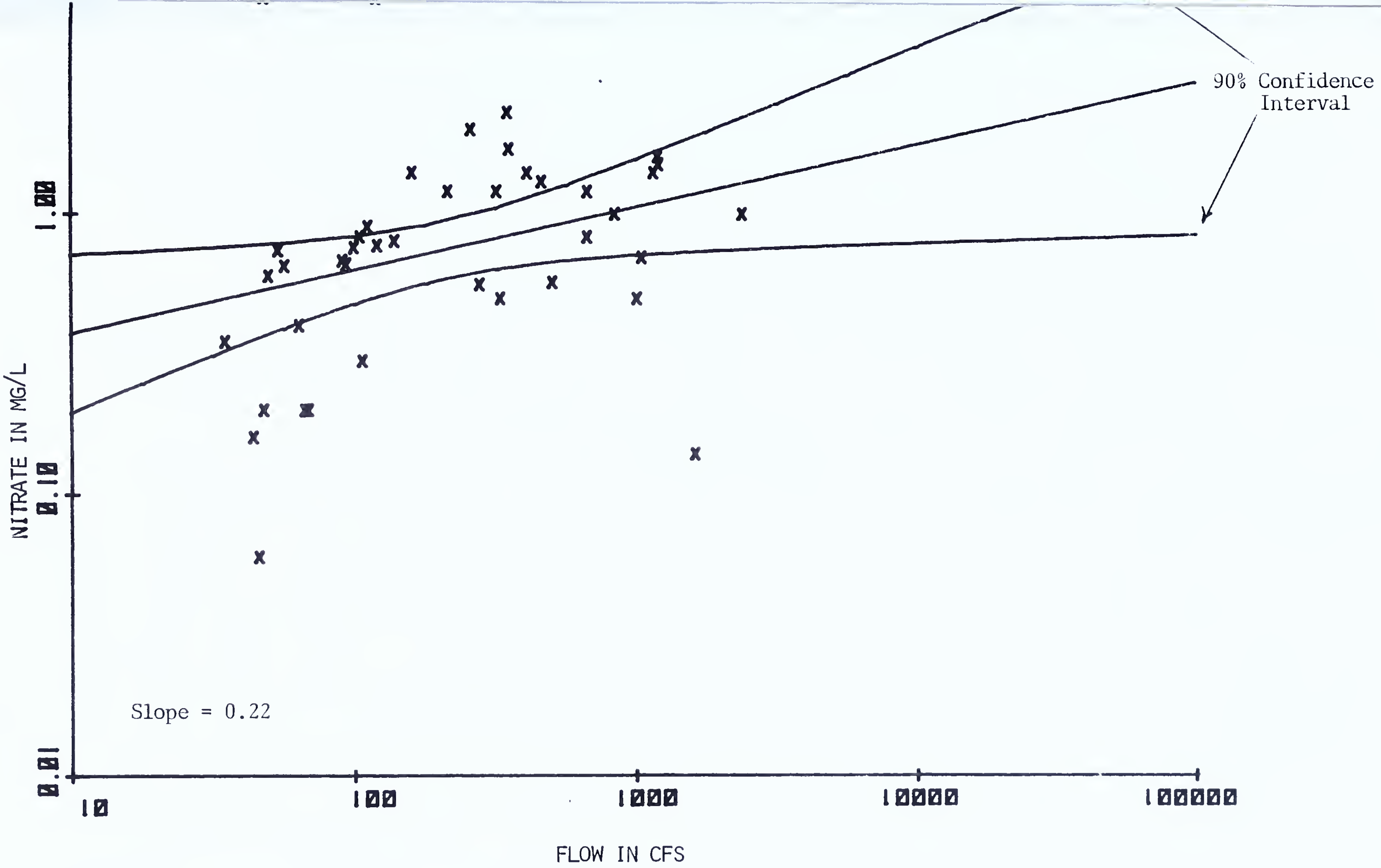

FIGURE 5C -- GRAPH SHOWING REGRESSION LINE FOR NITRATE AGAINST THE FLOW IN COHOCTON RIVER AT CAMPBELL, NEW YORK.

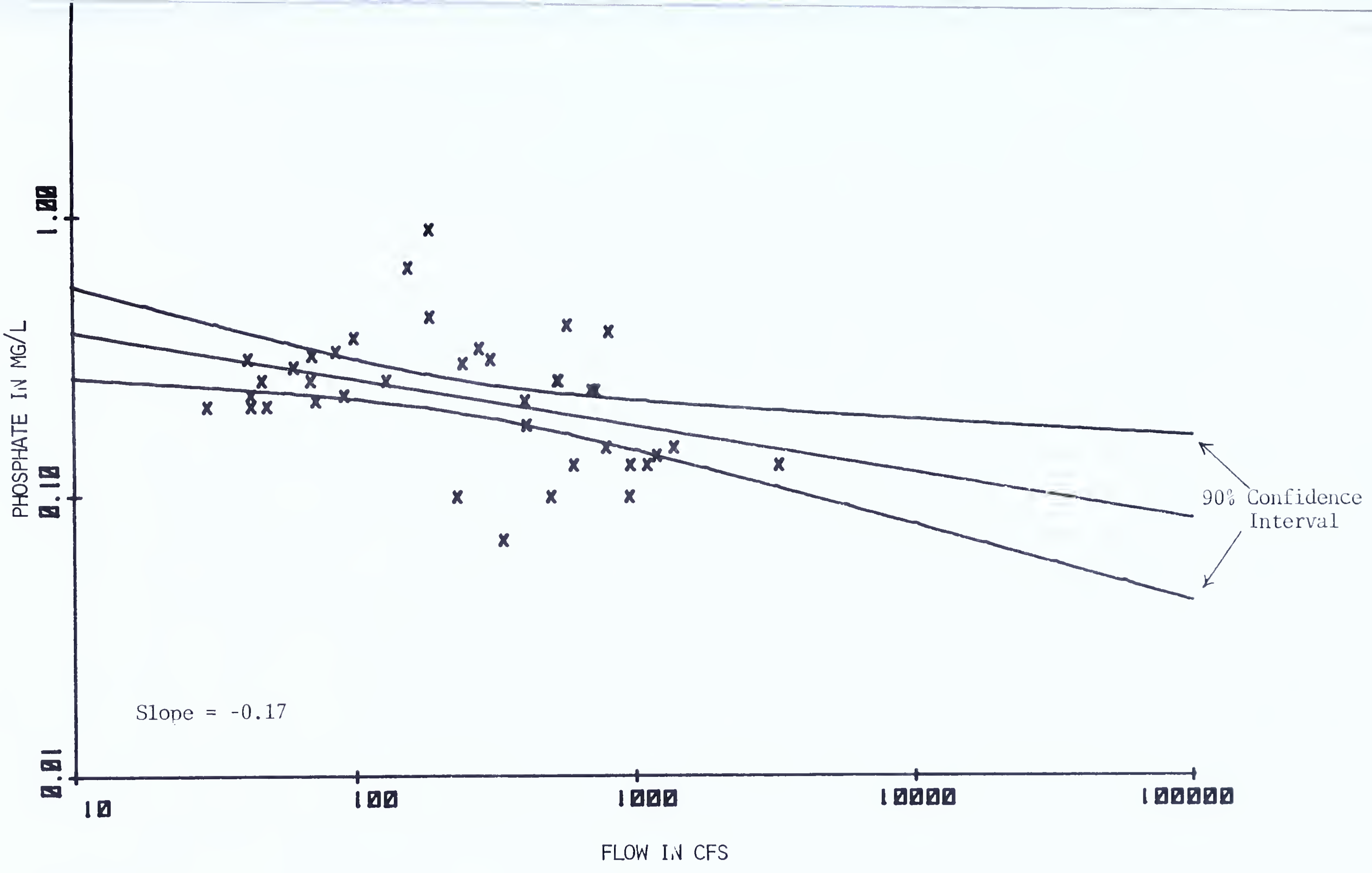

FIGURE 6A -- GRAPH SHOWING REGRESSION LINE FOR PHOSPHATE AGAINST THE FLOW IN TIOGA RIVER AT LINDLEY, NEW YORK.

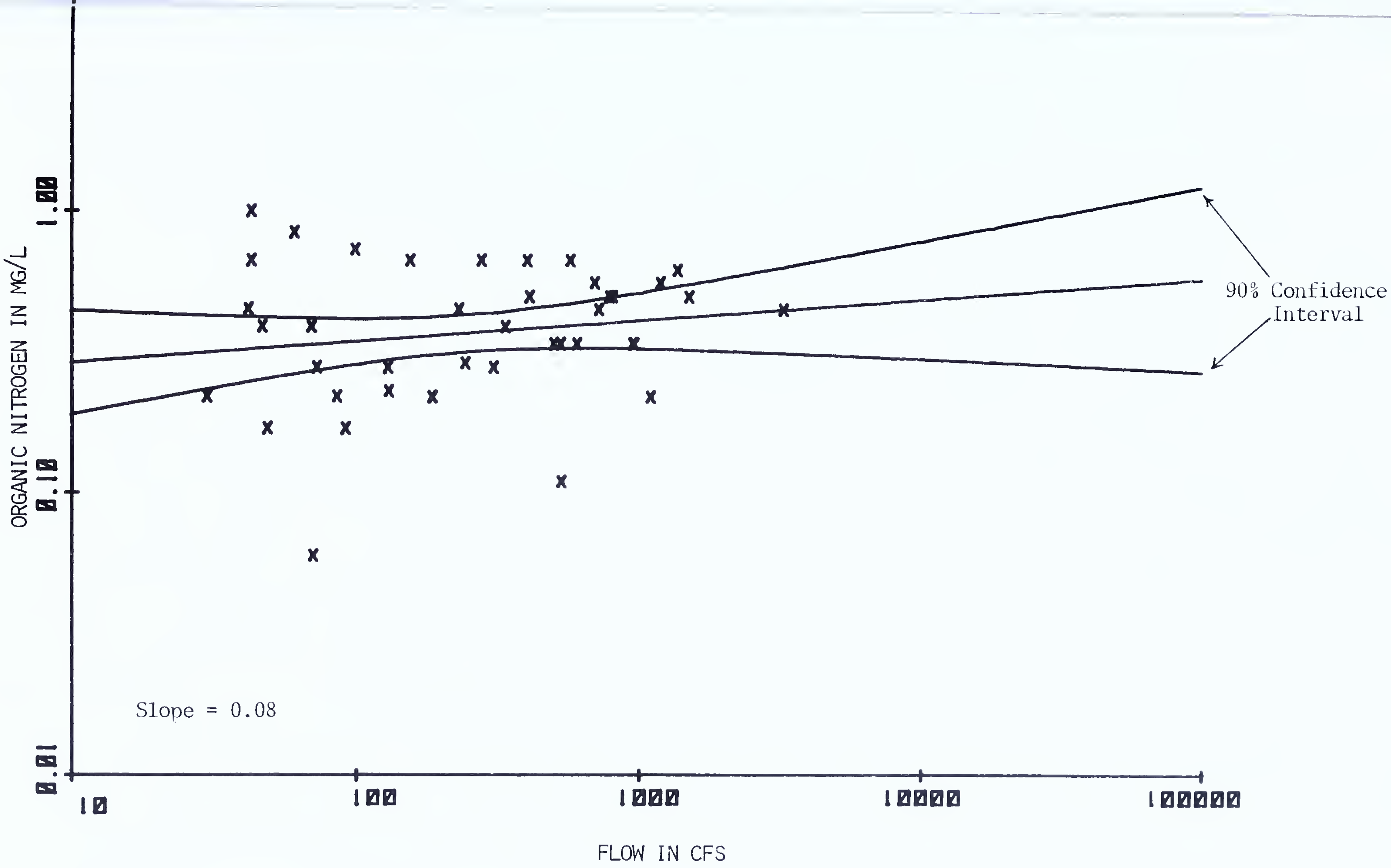

FIGURE 6B -- GRAPH SHOWING REGRESSION LINE FOR ORGANIC NITROGEN AGAINST THE FLOW IN TIOGA RIVER AT LINDLEY, NEW YORK.

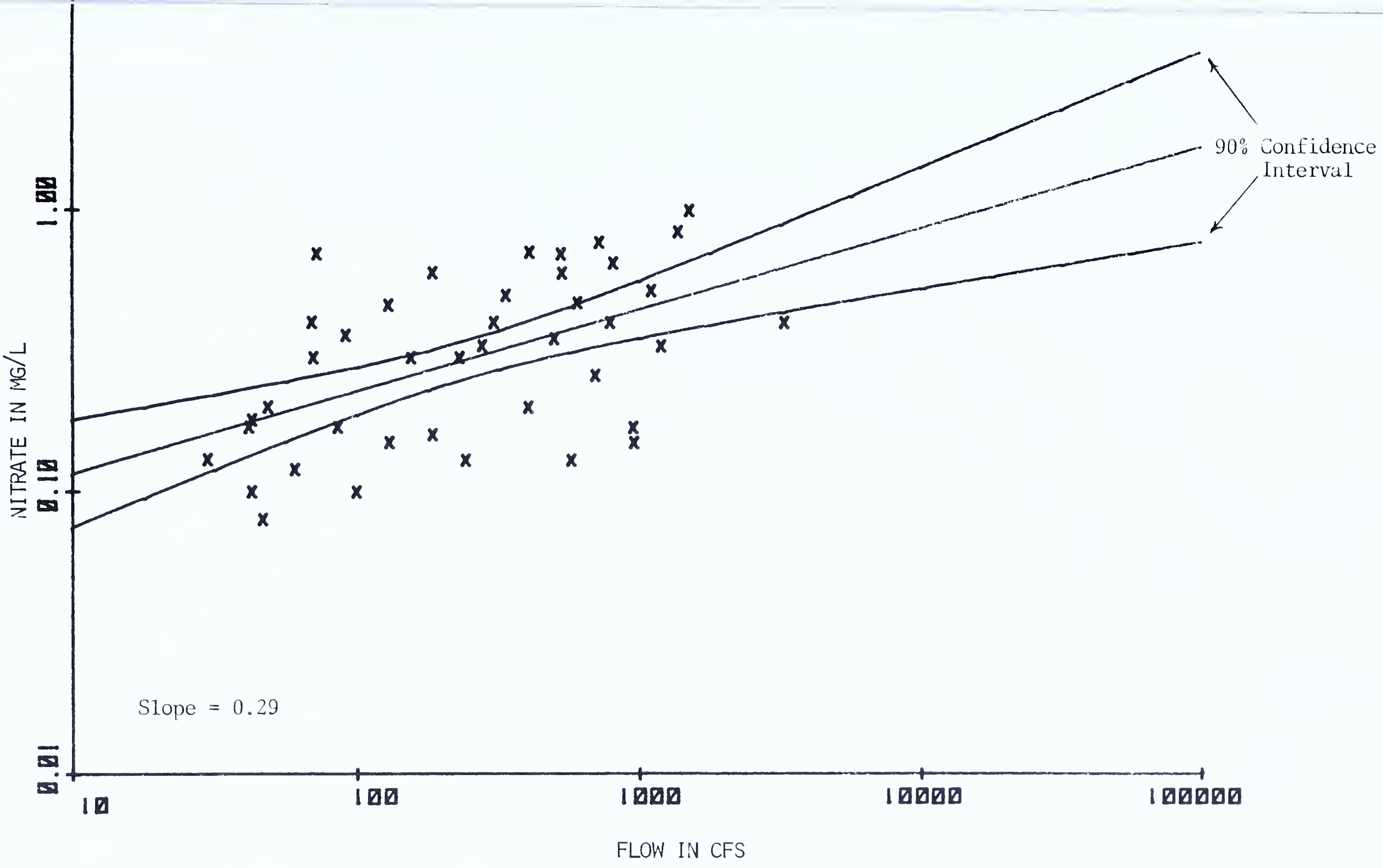

FIGURE 6C -- GRAPH SHOWING REGRESSION LINE FOR NITRATE AGAINST THE FLOW IN TIOGA RIVER AT LINDLEY, NEW YORK.

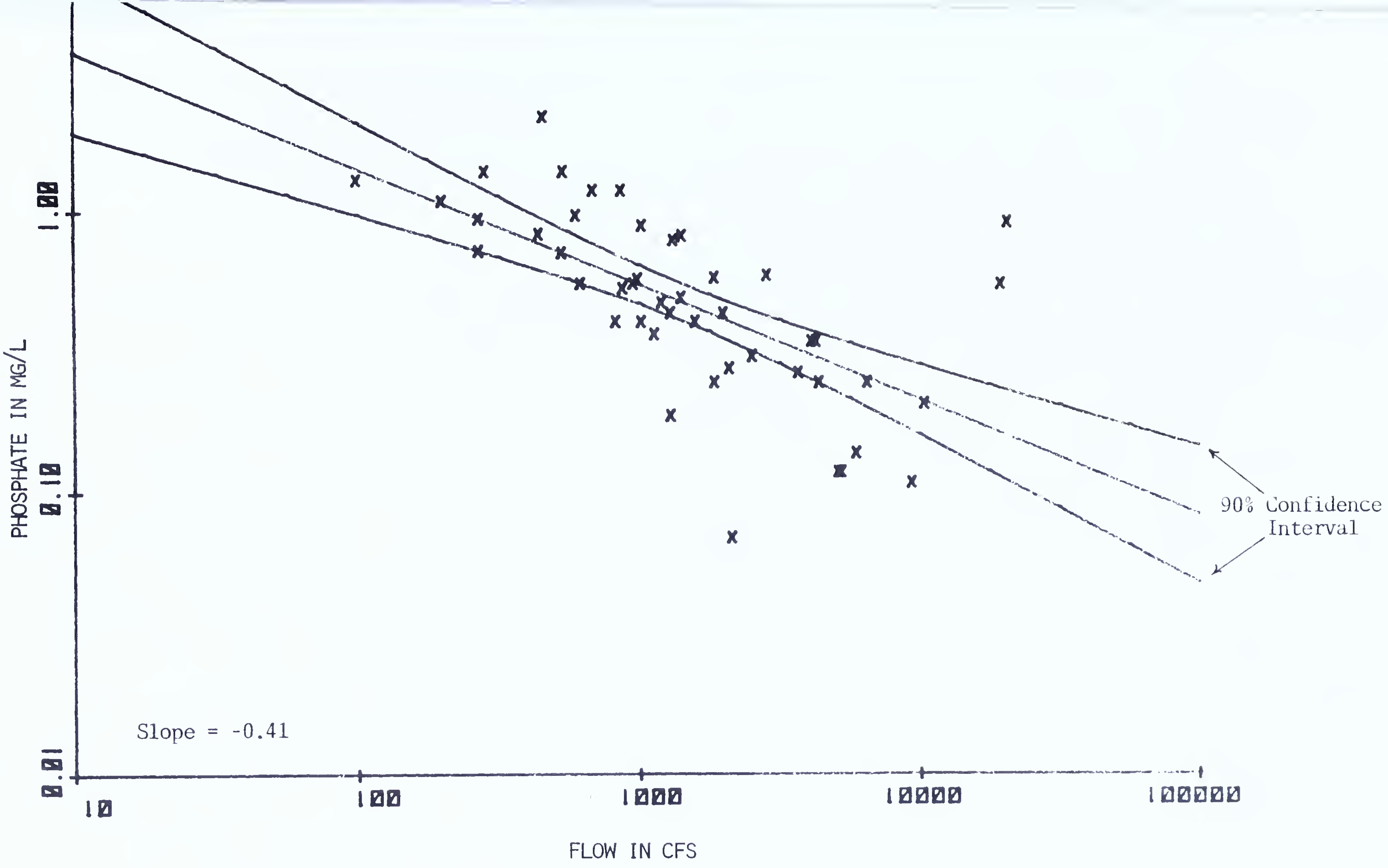

FIGURE 7A -- GRAPH SHOWING REGRESSION LINE FOR PHOSPHATE AGAINST THE FLOW IN CHEMUNG RIVER AT CHEMUNG, NEW YORK.

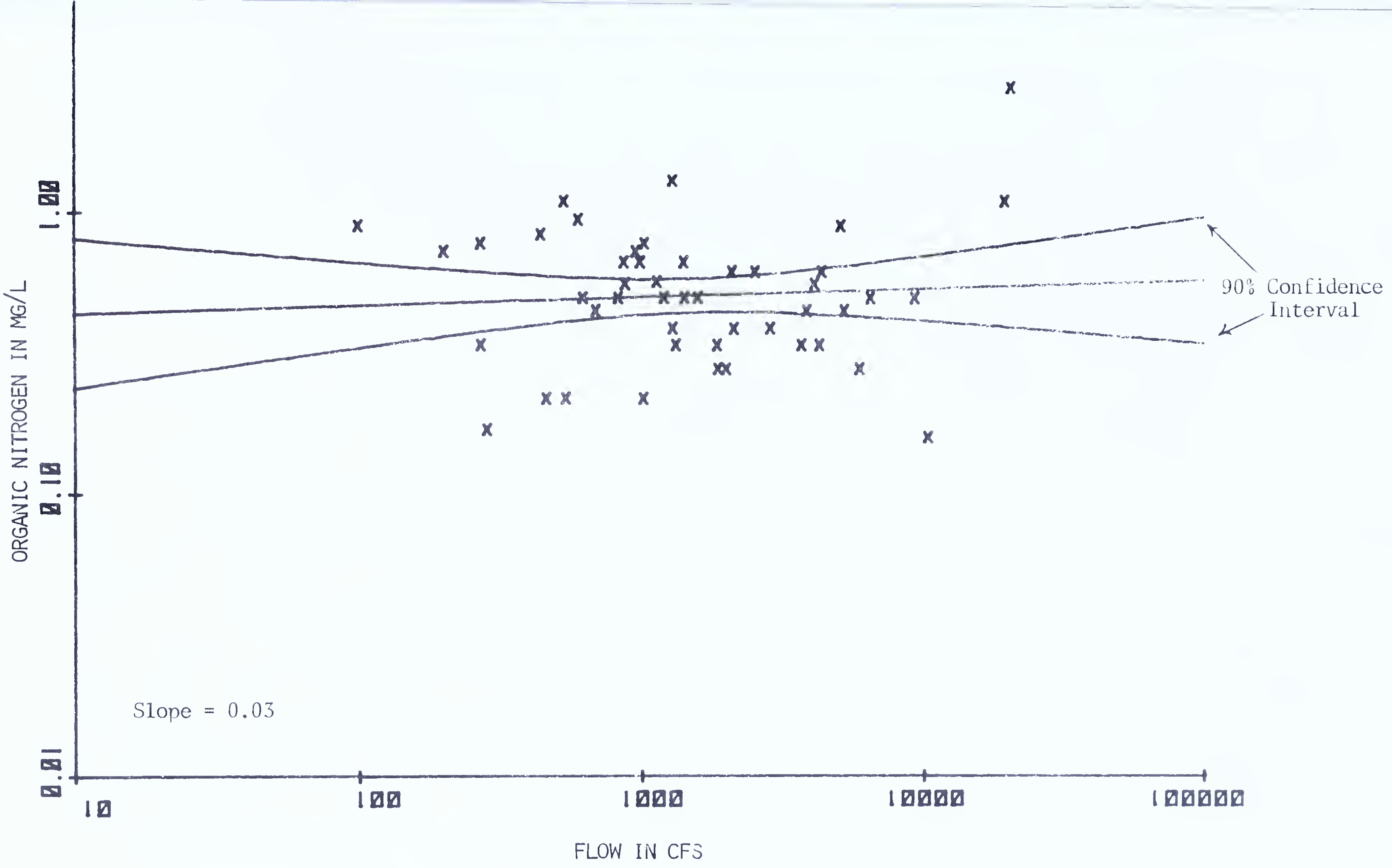

FIGURE 7B -- GRAPH SHOWING REGRESSION LINE FOR ORGANIC NITROGEN AGAINST THE FLOW IN CHEMUNG RIVER AT CHEMUNG, NEW YORK.

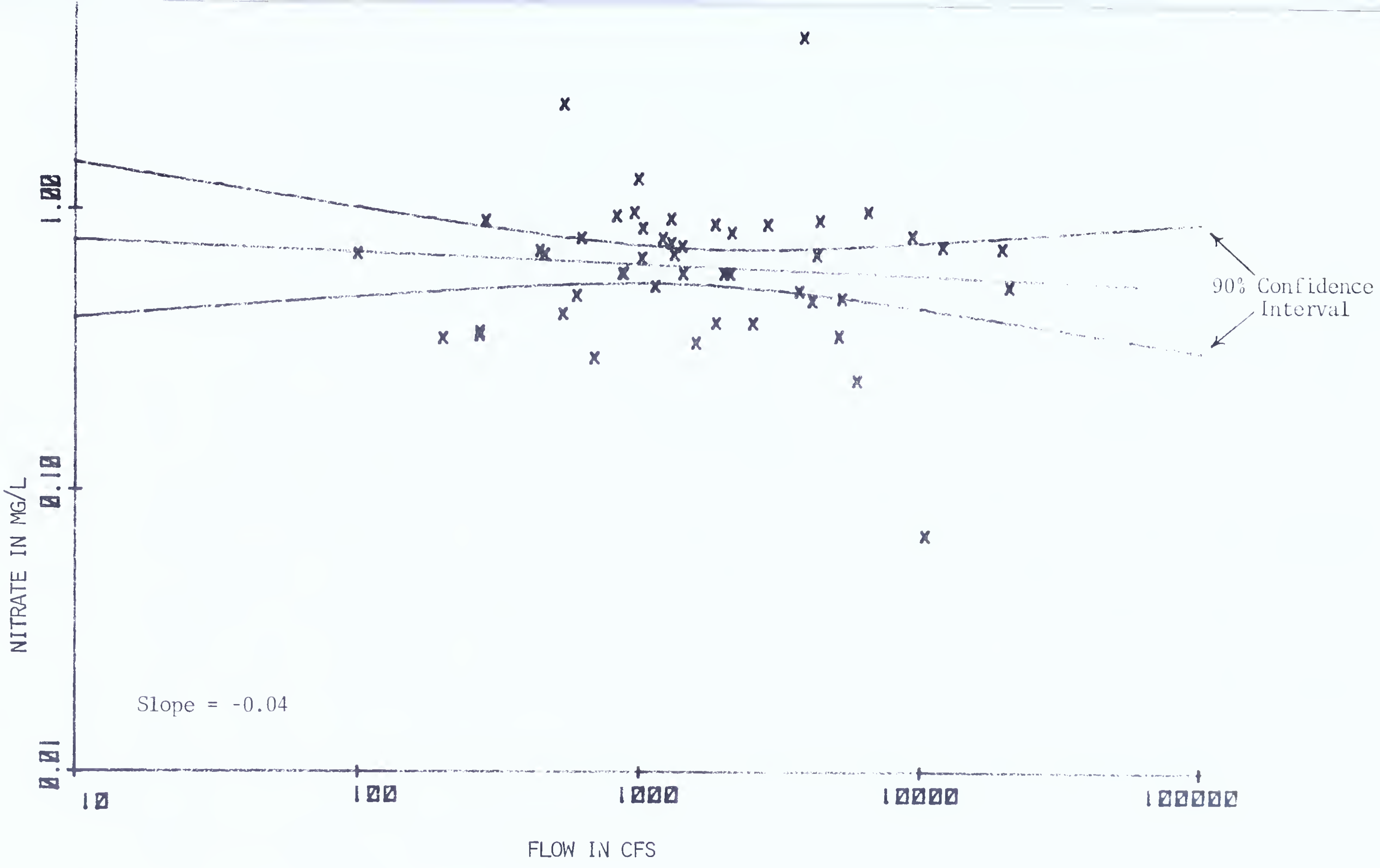

FIGURE 7C -- GRAPH SHOWING REGRESSION LINE FOR NITRATE AGAINST THE FLOW IN CHEMUNG RIVER AT CHEMUNG, NEW YORK.

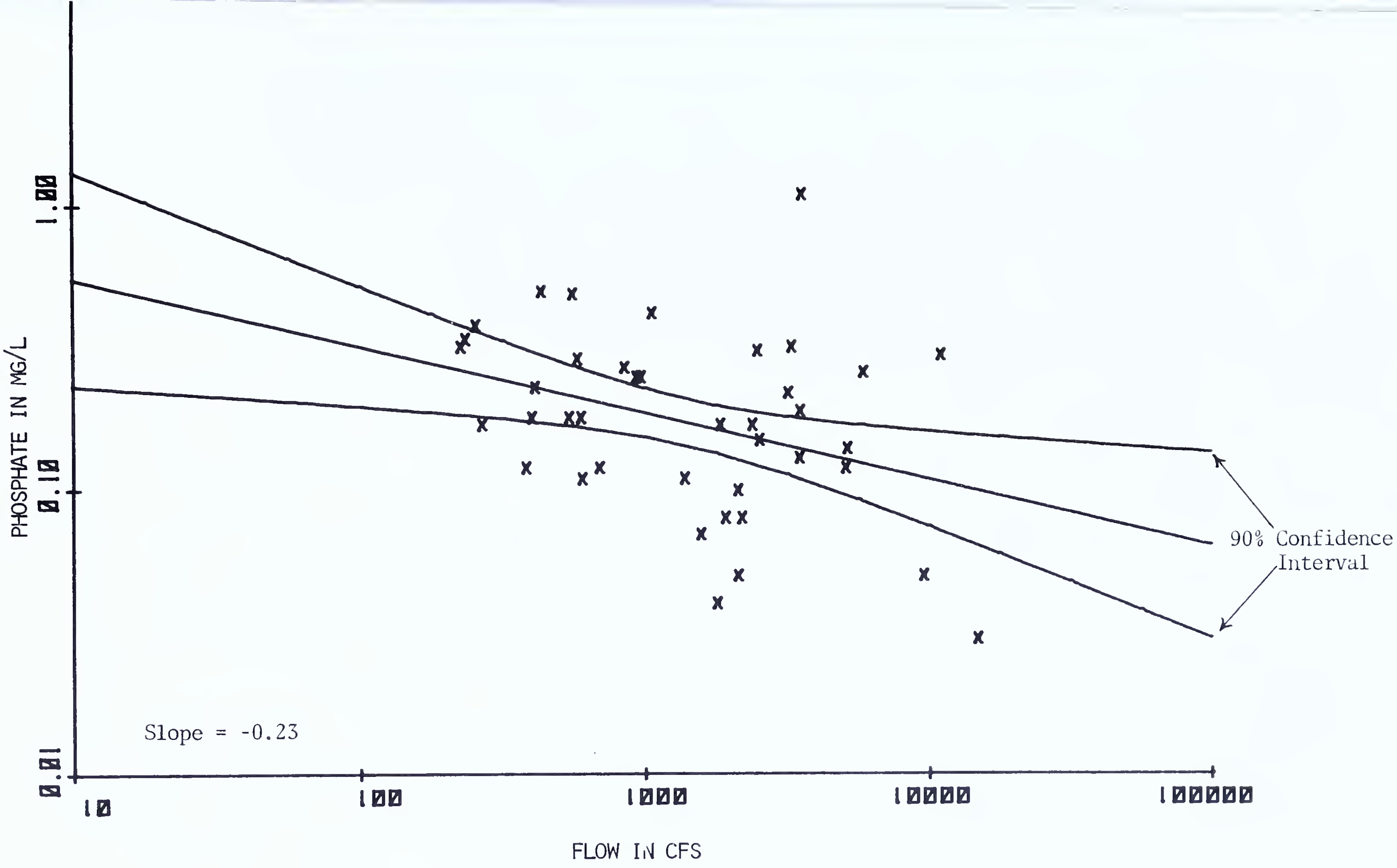

FIGURE 10A -- GRAPH SHOWING REGRESSION LINE FOR PHOSPHATE AGAINST THE FLOW IN SUSQUEHANNA RIVER AT BAINBRIDGE, NEW YORK.

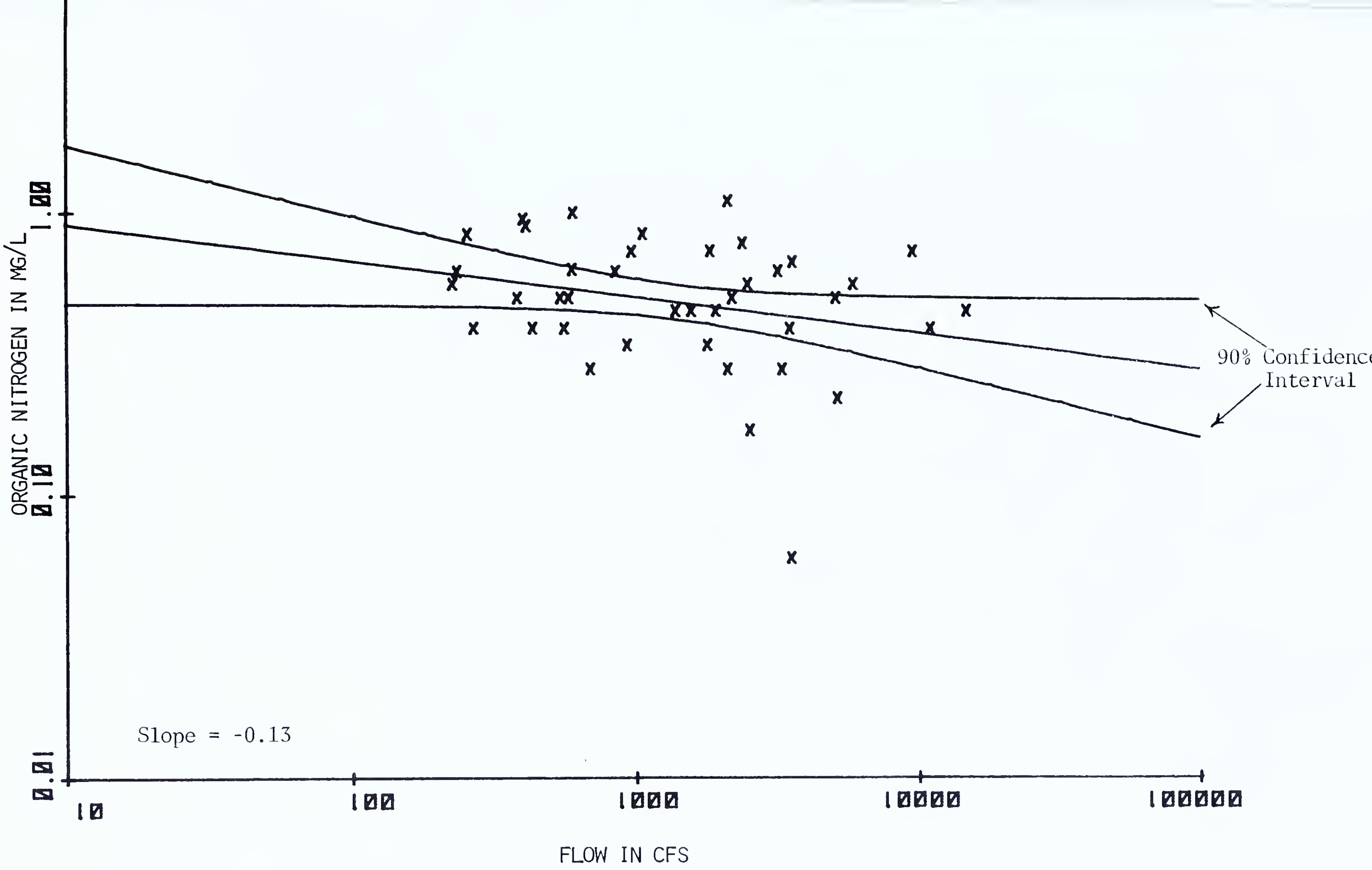

FIGURE 10B -- GRAPH SHOWING REGRESSION LINE FOR ORGANIC NITROGEN AGAINST THE FLOW IN SUSQUEHANNA RIVER AT BAINBRIDGE, NEW YORK.

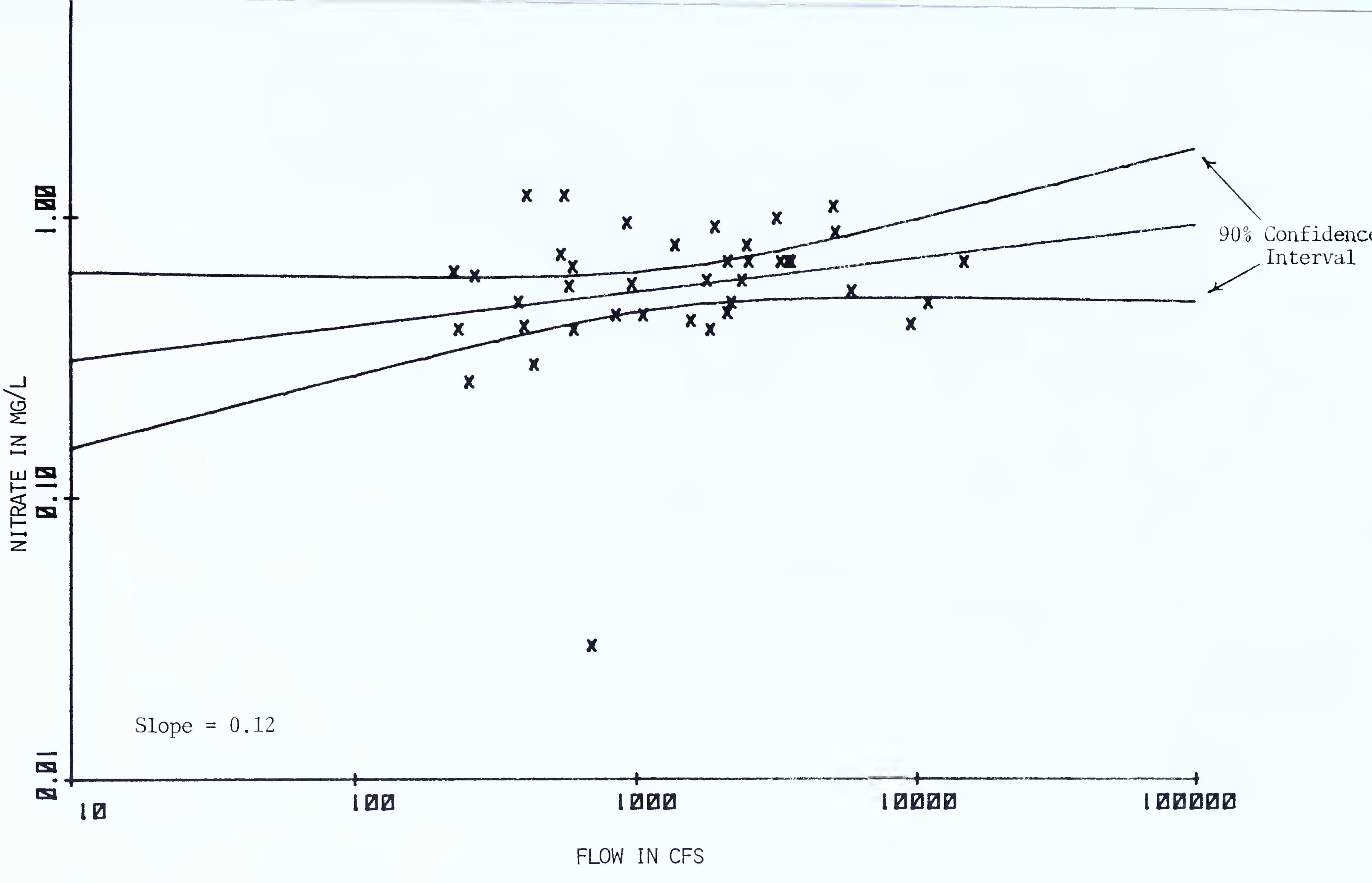

FIGURE 10C -- GRAPH SHOWING REGRESSION LINE FOR NITRATE AGAINST THE FLOW IN SUSQUEHANNA RIVER AT BAINBRIDGE, NEW YORK.

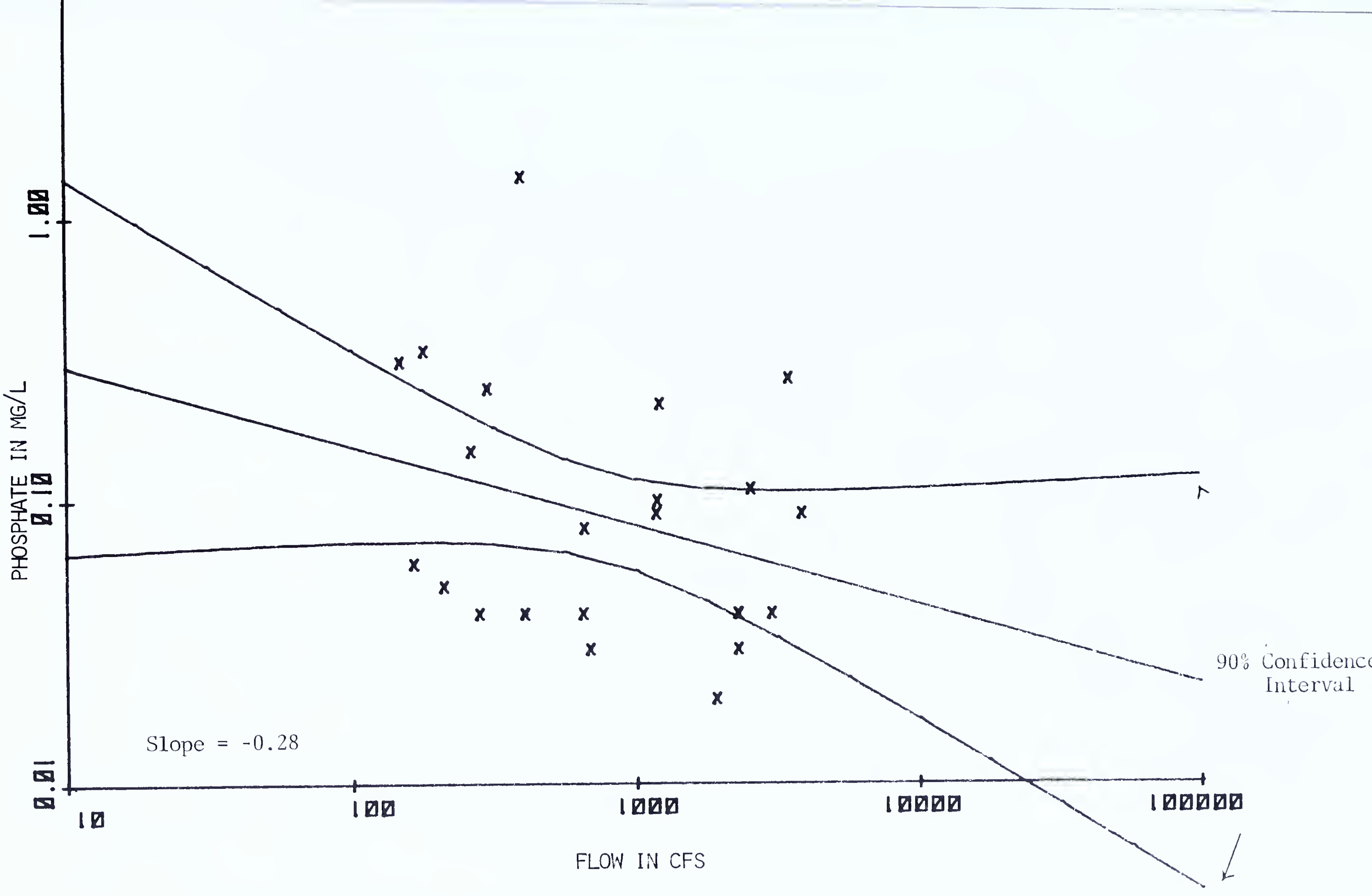

FIGURE 11A -- GRAPH SHOWING REGRESSION LINE FOR PHOSPHATE AGAINST THE FLOW IN SUSQUEHANNA RIVER AT UNADILLA, NEW YORK.

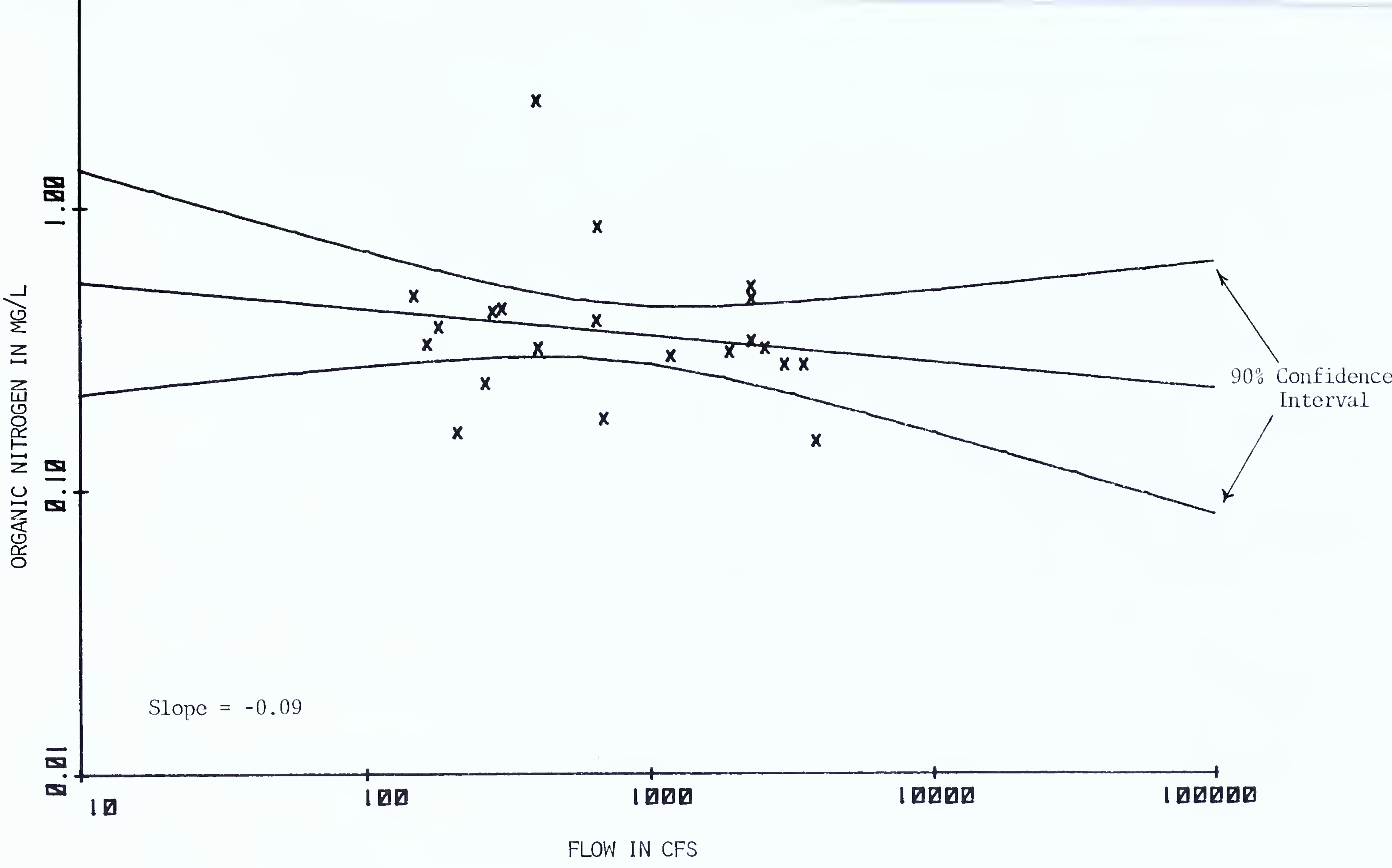

FIGURE 11B -- GRAPH SHOWING REGRESSION LINE FOR ORGANIC NITROGEN AGAINST THE FLOW IN SUSQUEHANNA RIVER AT UNADILLA, NEW YORK.

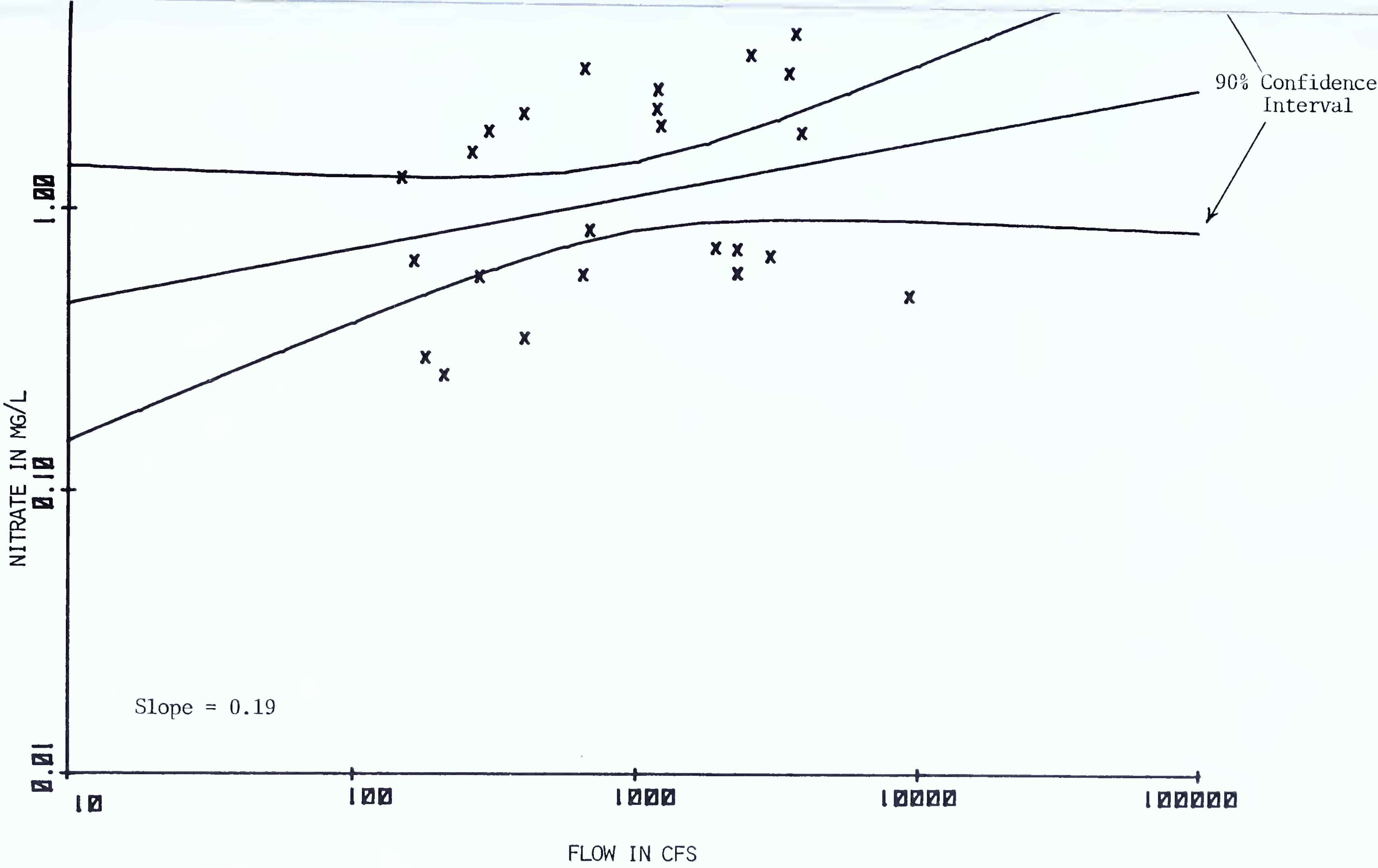

FIGURE 11C -- GRAPH SHOWING REGRESSION LINE FOR NITRATE AGAINST THE FLOW IN SUSQUEHANNA RIVER AT UNADILLA, NEW YORK.

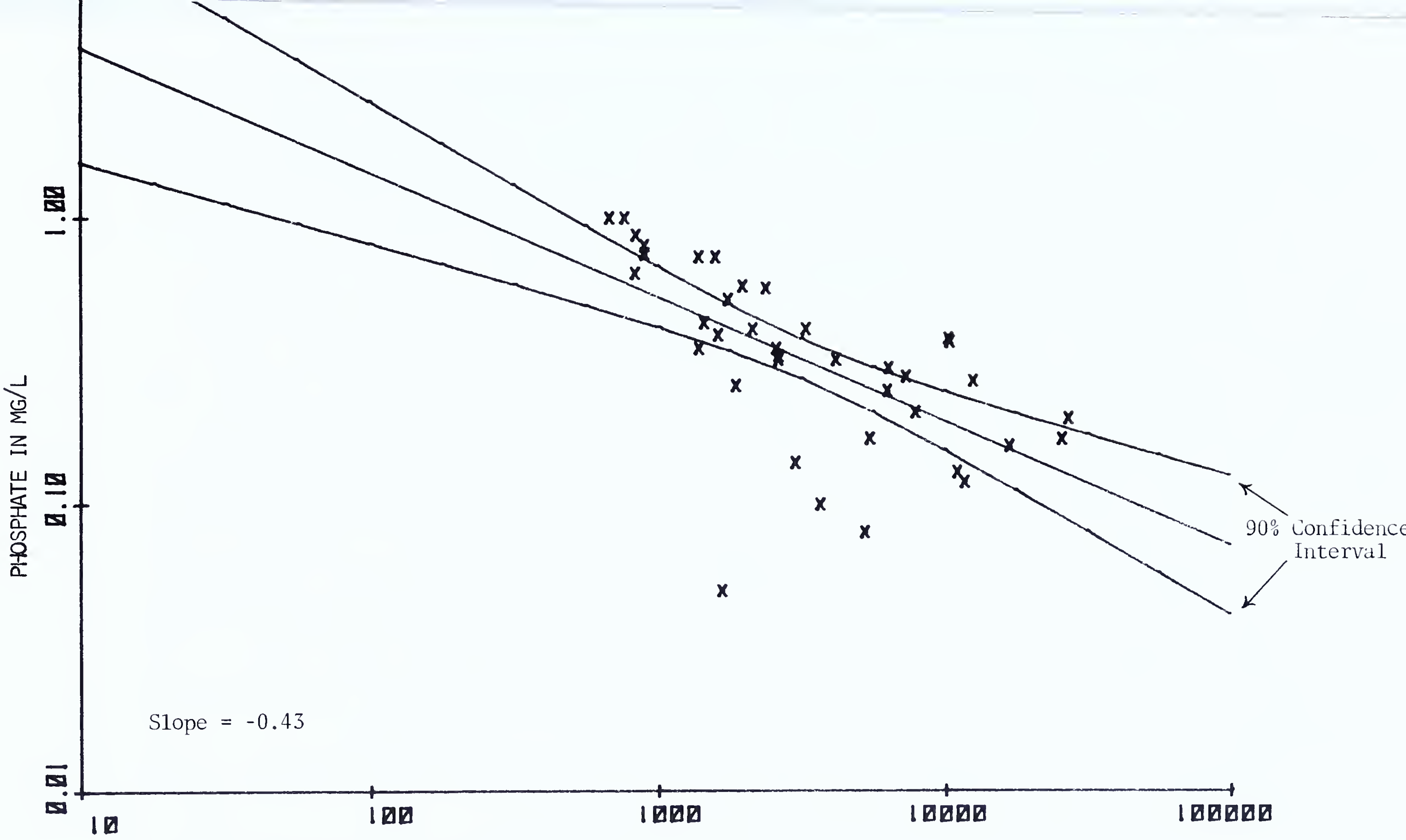

FIGURE 12A -- GRAPH SHOWING REGRESSION LINE FOR PHOSPHATE AGAINST THE FLOW IN SUSQUEHANNA RIVER AT VESTAL, NEW YORK.

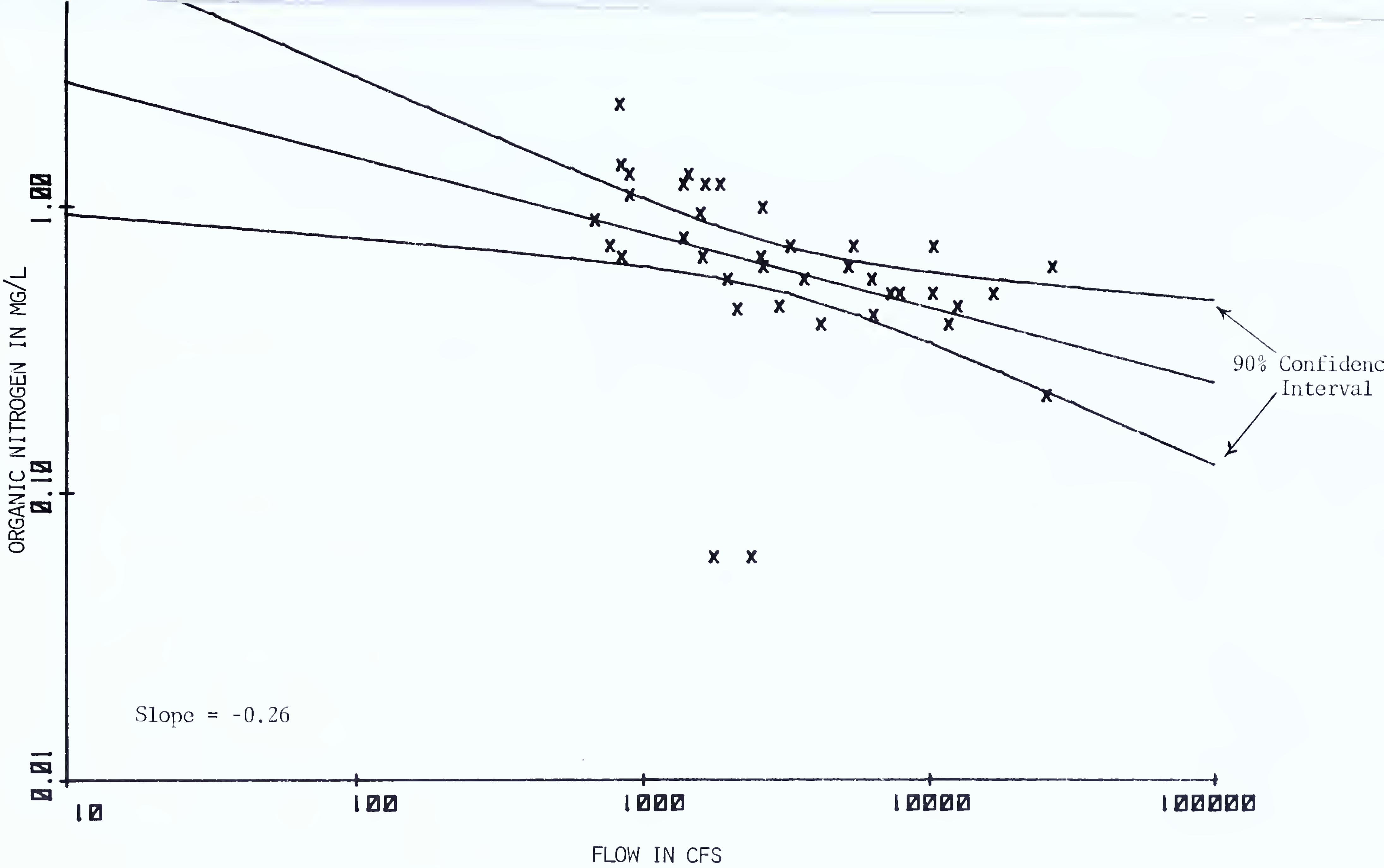

FIGURE 12B -- GRAPH SHOWING REGRESSION LINE FOR ORGANIC NITROGEN AGAINST THE FLOW IN SUSQUEHANNA RIVER AT VESTAL, NEW YORK.

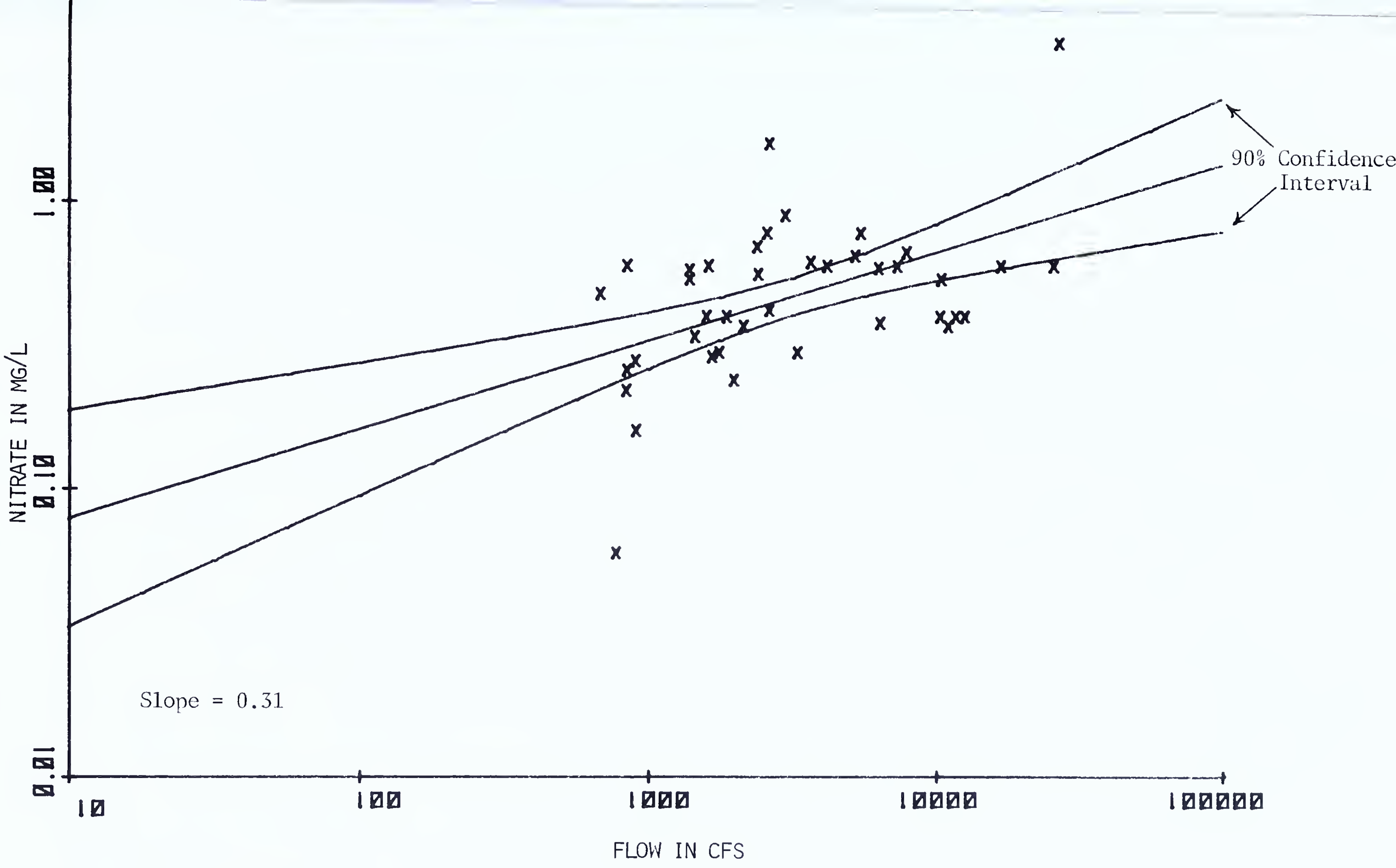

FIGURE 12C -- GRAPH SHOWING REGRESSION LINE FOR NITRATE AGAINST THE FLOW IN SUSQUEHANNA RIVER AT VESTAL, NEW YORK.

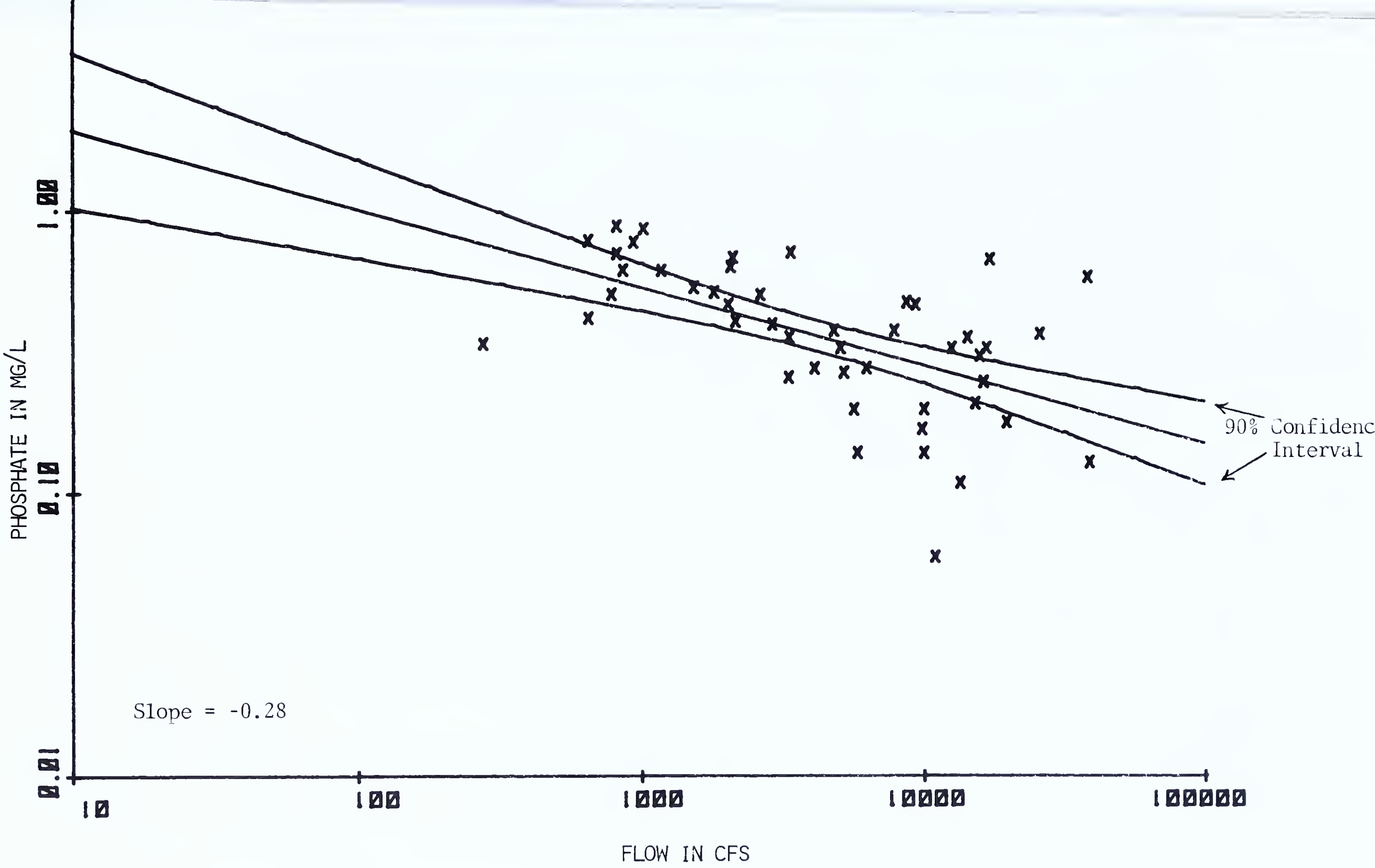

FIGURE 13A -- GRAPH SHOWING REGRESSION LINE FOR PHOSPHATE AGAINST THE FLOW IN SUSQUEHANNA RIVER AT SMITHBORO, NEW YORK.

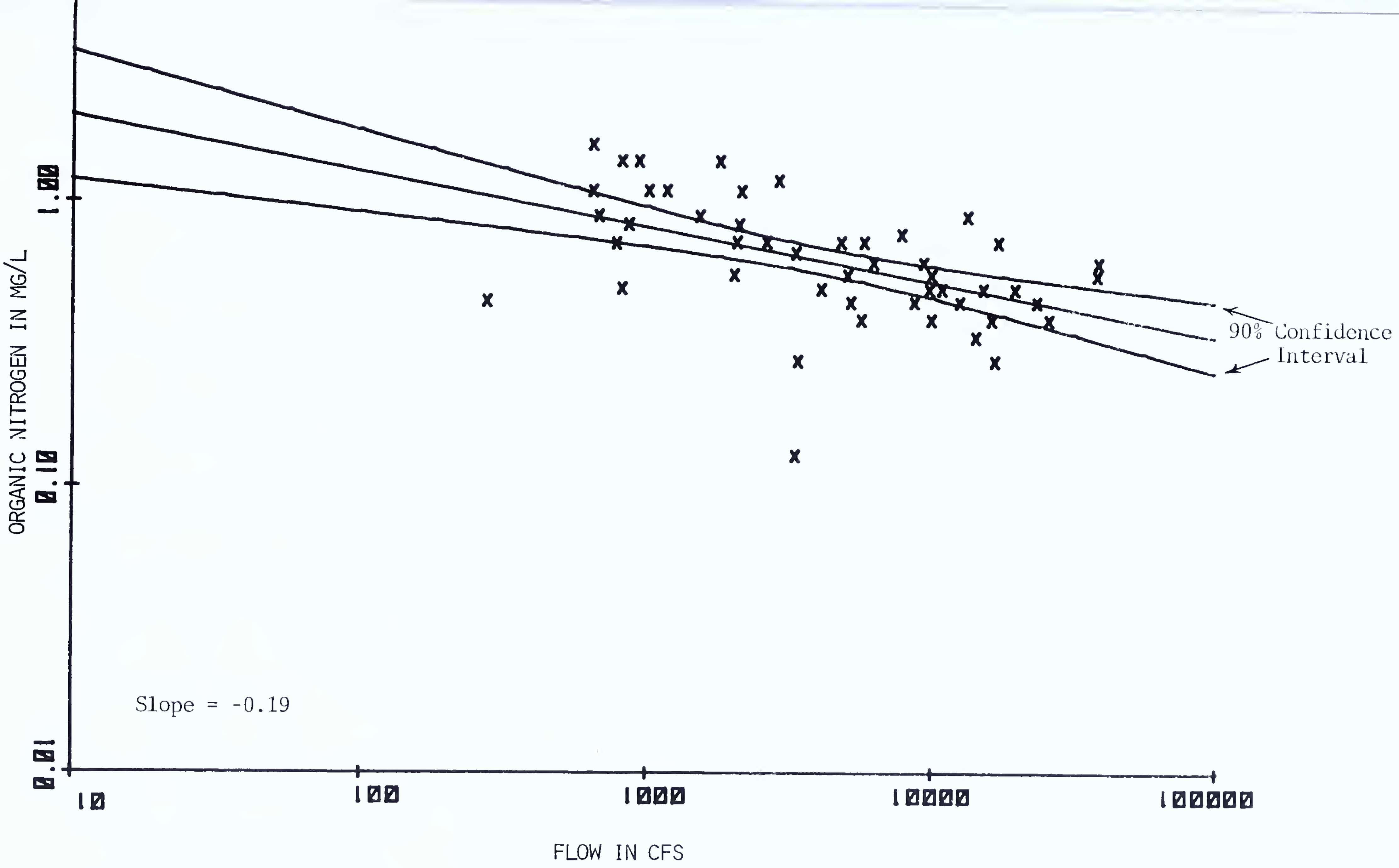

FIGURE 13B -- GRAPH SHOWING REGRESSION LINE FOR ORGANIC NITROGEN AGAINST THE FLOW IN SUSQUEHANNA RIVER AT SMITHBORO, NEW YORK.

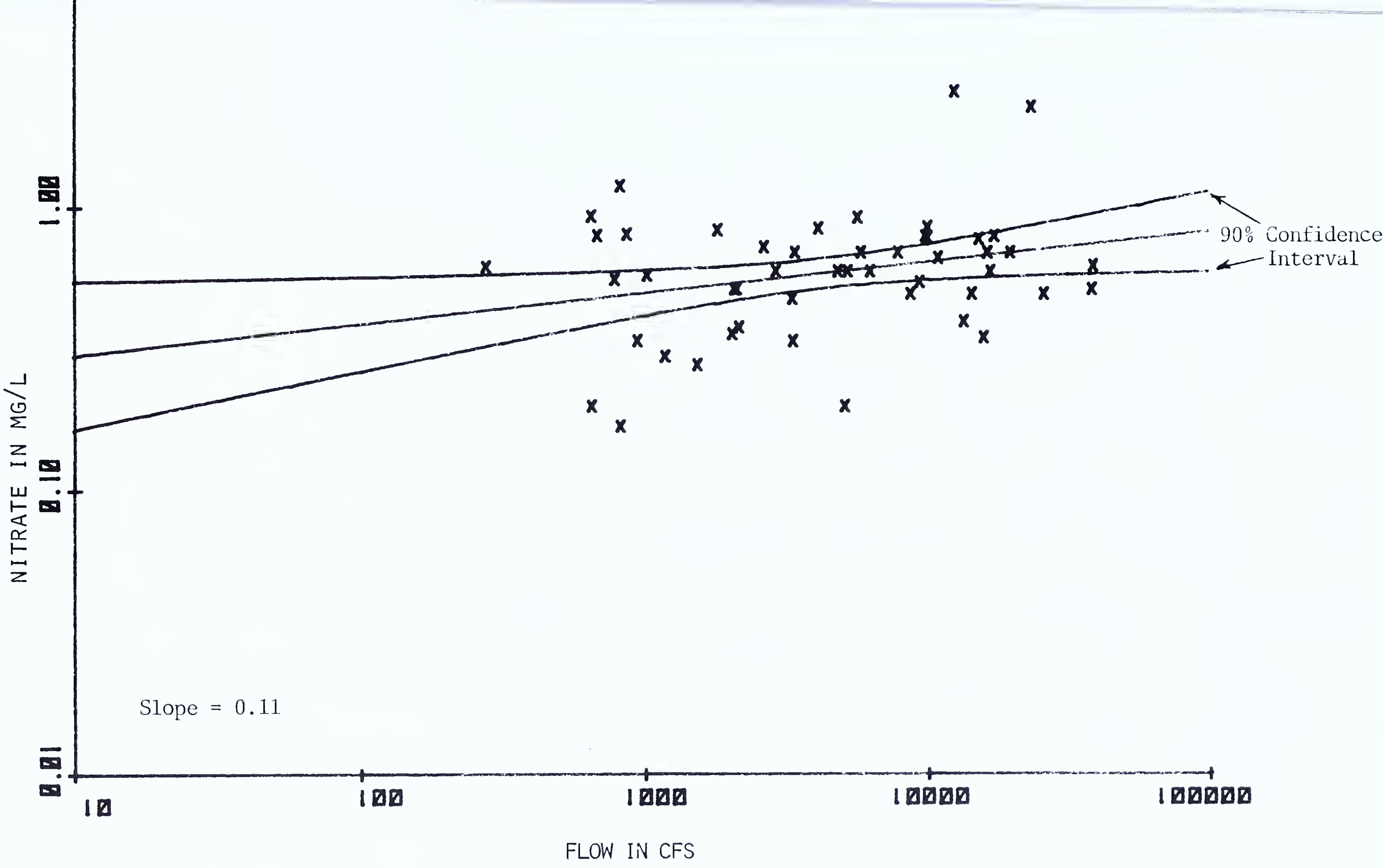

FIGURE 13C -- GRAPH SHOWING REGRESSION LINE FOR NITRATE AGAINST THE FLOW IN SUSQUEHANNA RIVER AT SMITHBORO, NEW YORK.

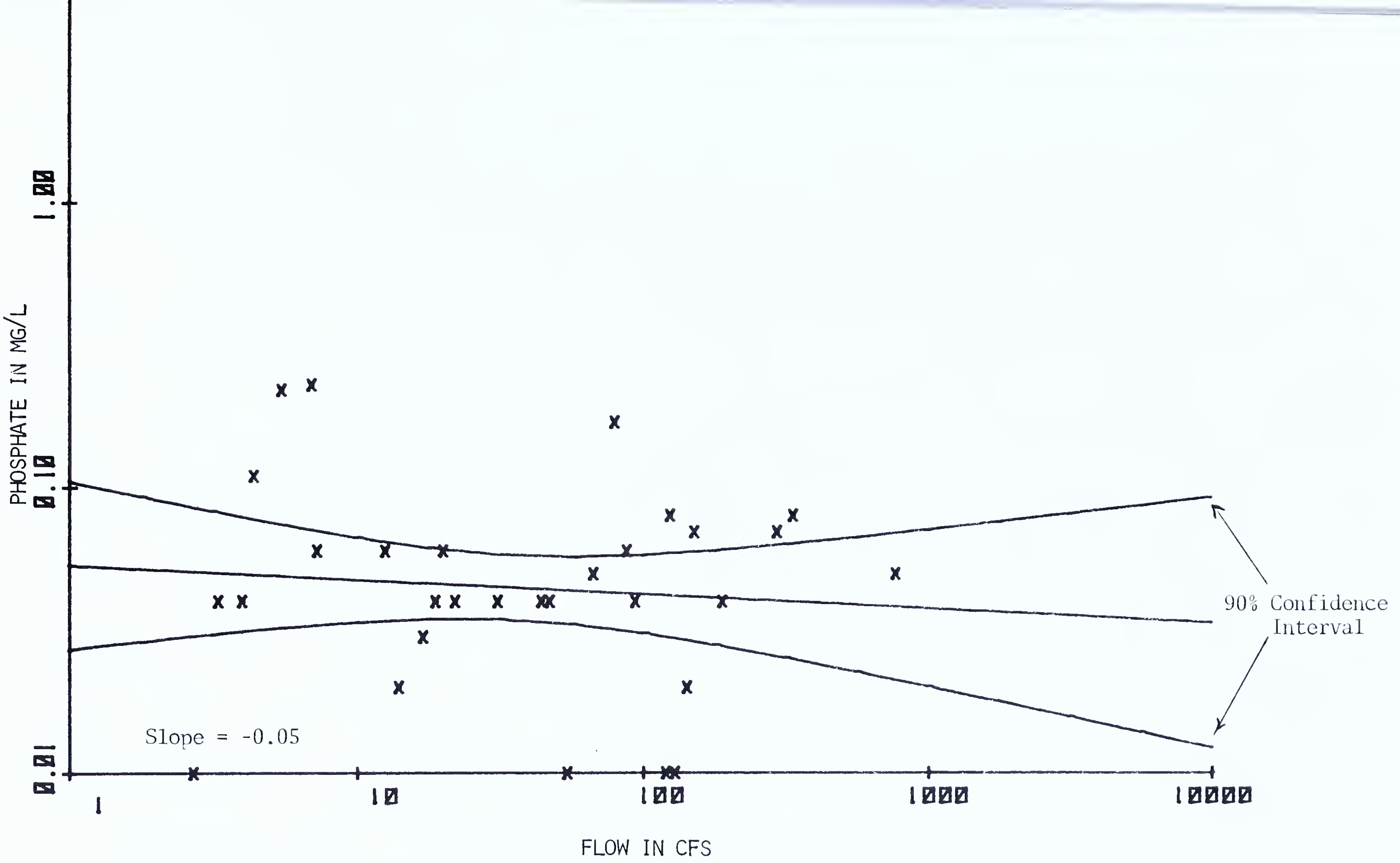

FIGURE 14A -- GRAPH SHOWING REGRESSION LINE FOR PHOSPHATE AGAINST THE FLOW IN GENEGANSLET CREEK AT SMITHVILLE FLATS, NEW YORK.

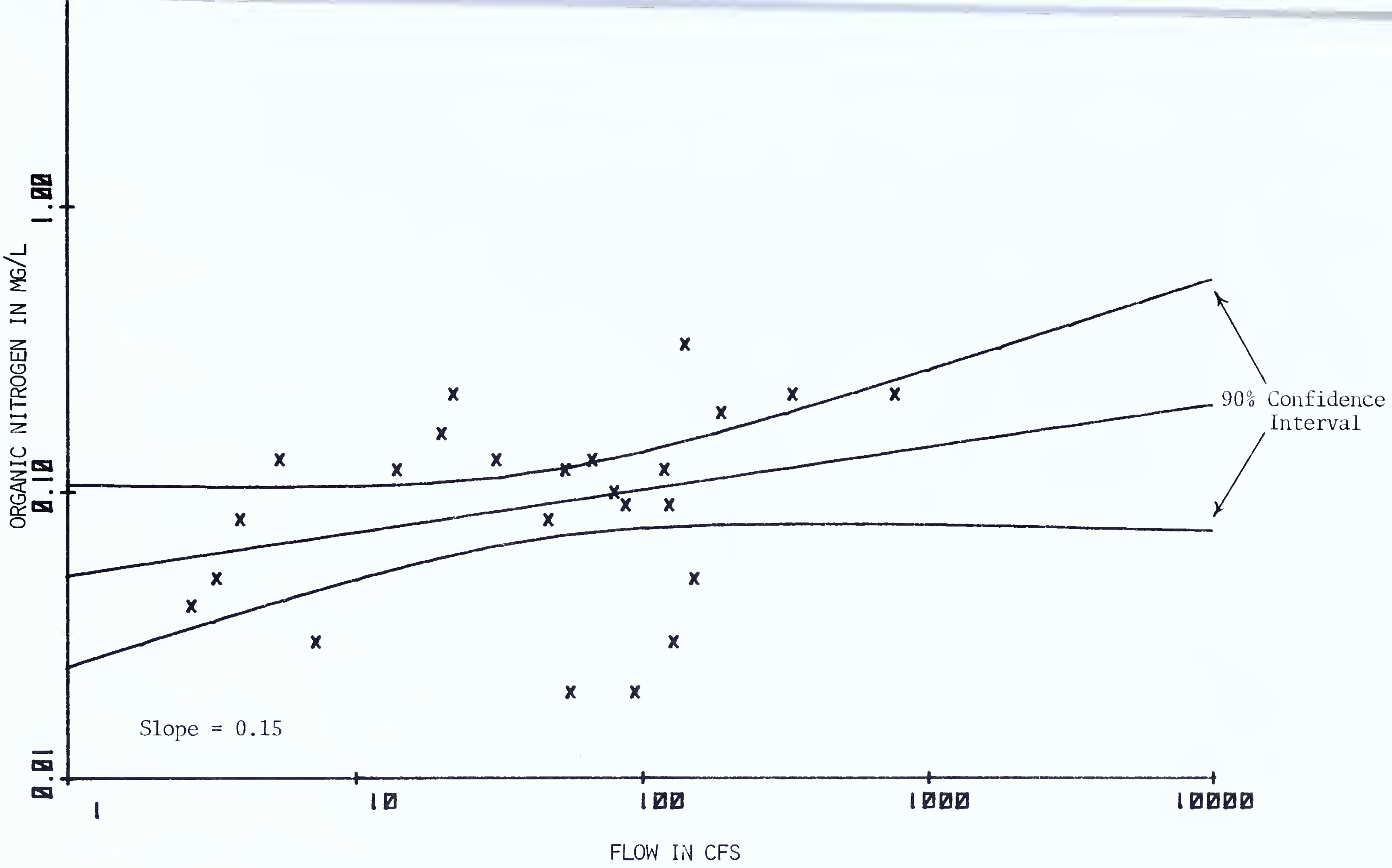

FIGURE 14B -- GRAPH SHOWING REGRESSION LINE FOR ORGANIC NITROGEN AGAINST THE FLOW IN GENEGANSLET CREEK AT SMITHVILLE FLATS, NEW YORK.

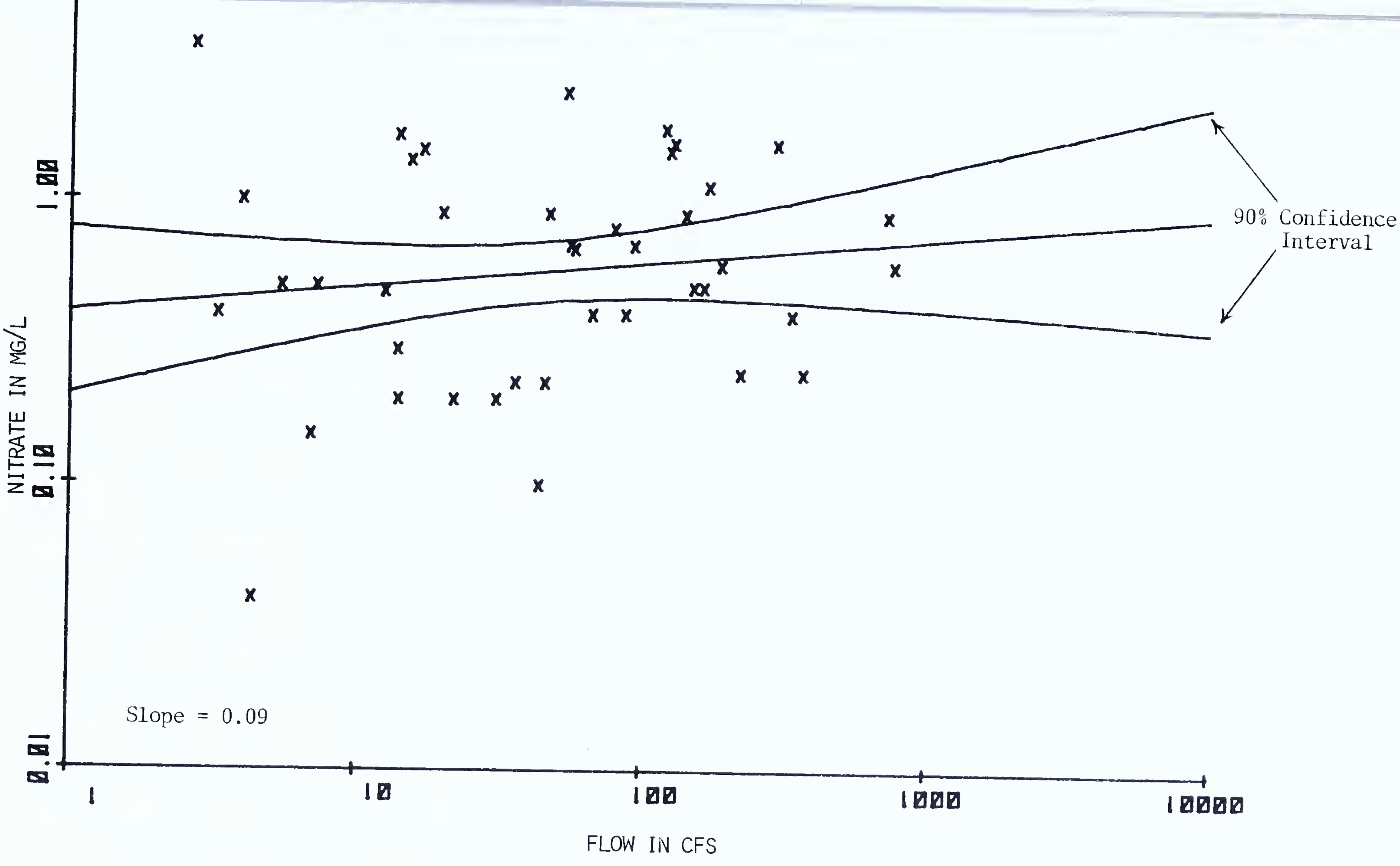

FIGURE 14C -- GRAPH SHOWING REGRESSION LINE FOR NITRATE AGAINST THE FLOW IN GENEGANSLET CREEK AT SMITHVILLE FLATS, NEW YORK.

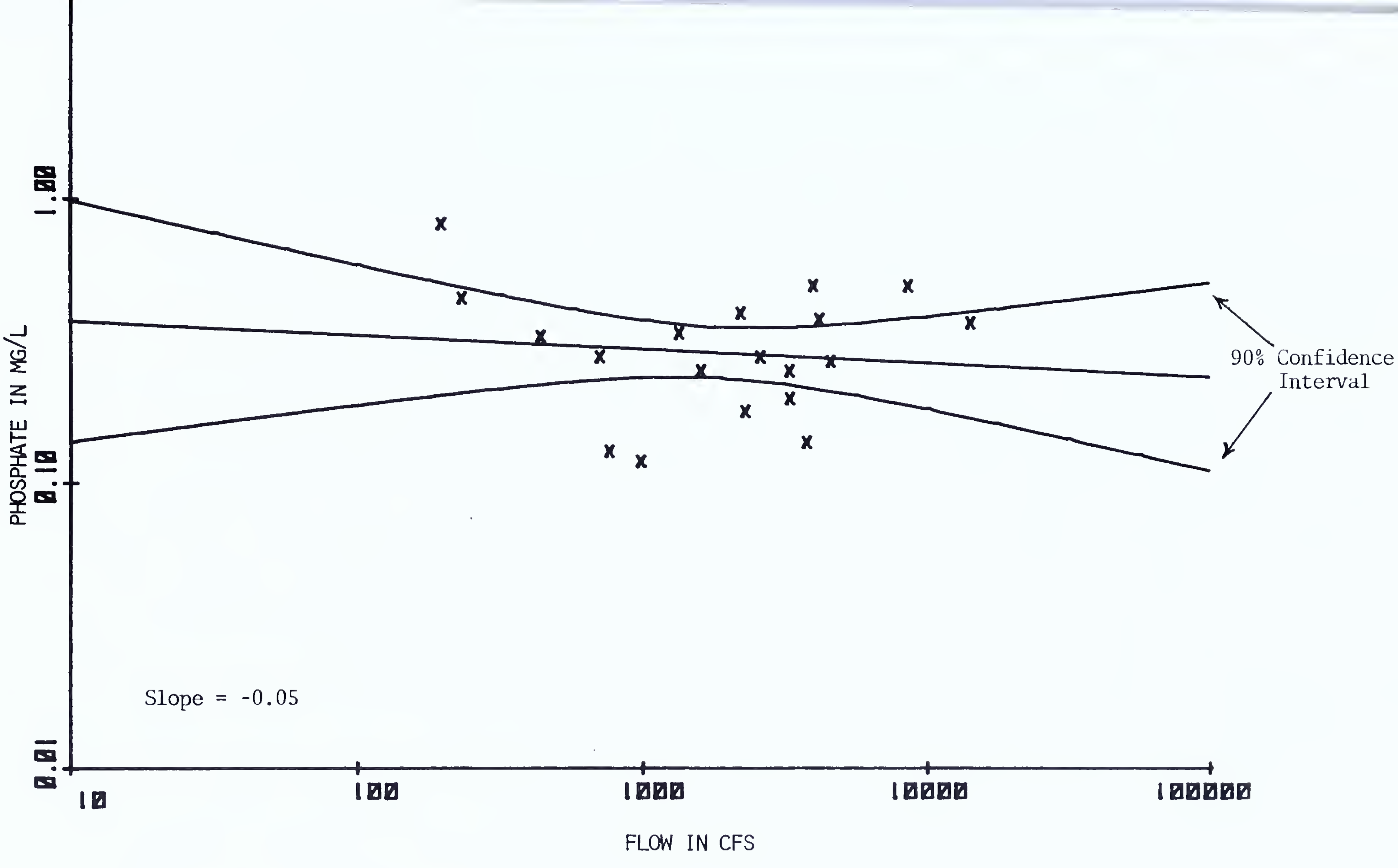

FIGURE 15A — GRAPH SHOWING REGRESSION LINE FOR PHOSPHATE AGAINST THE FLOW IN CHENANGO RIVER ABOVE CONFLUENCE OF TIOUGHNIOGA RIVER.

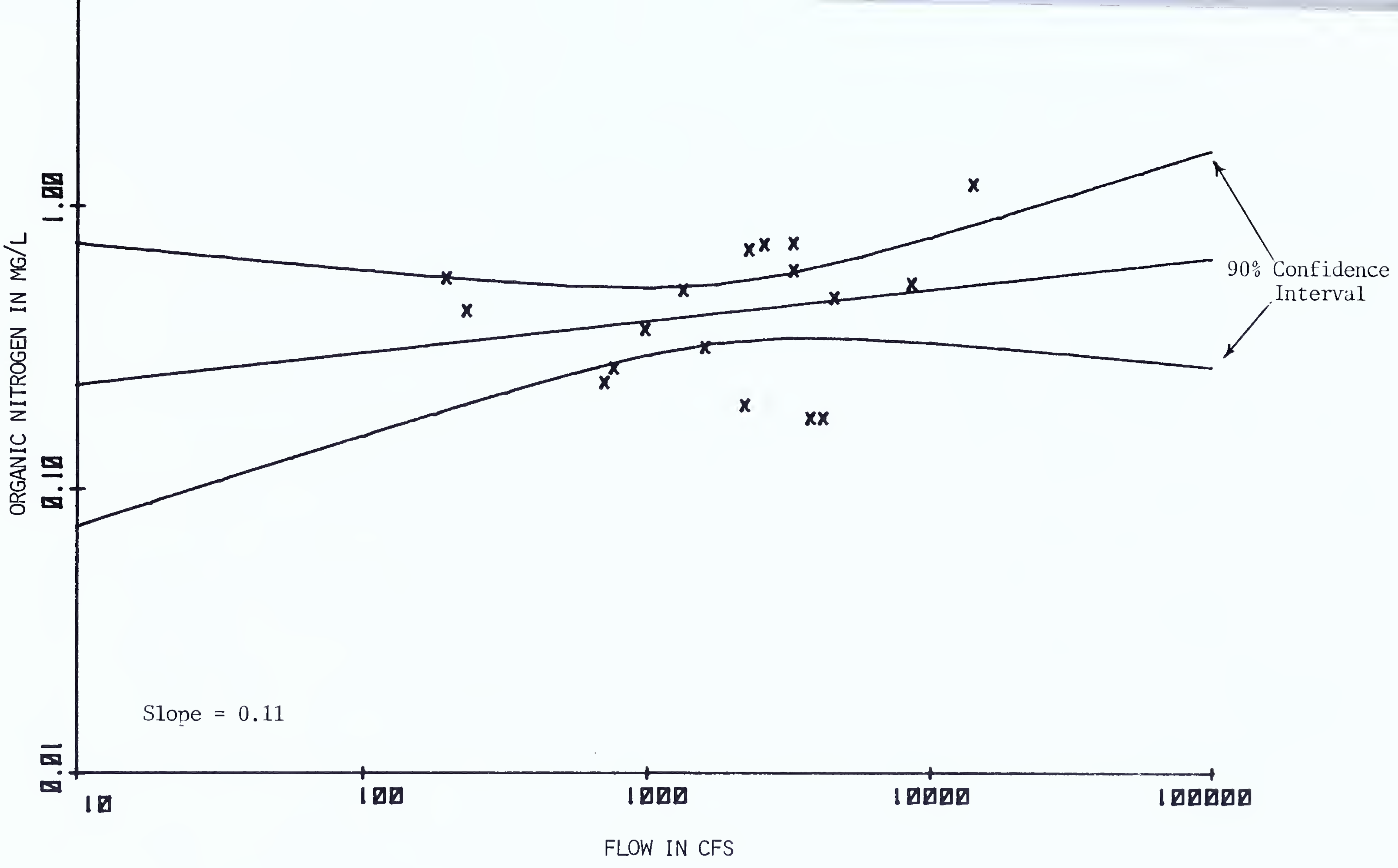

FIGURE 15B -- GRAPH SHOWING REGRESSION LINE FOR ORGANIC NITROGEN AGAINST THE FLOW IN CHENANGO RIVER ABOVE CONFLUENCE OF TIOUGHNIOTA RIVER.

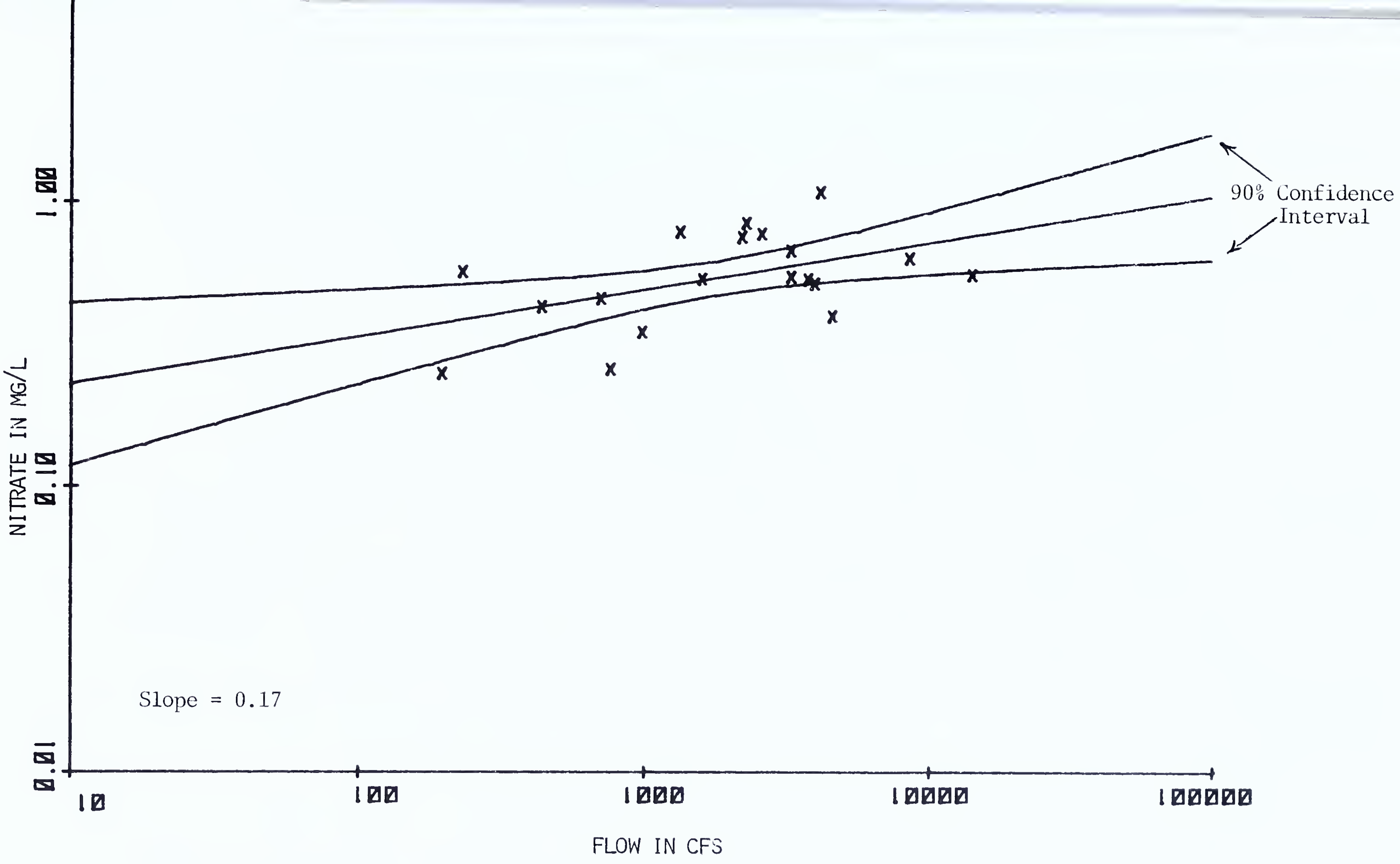

FIGURE 15C -- GRAPH SHOWING REGRESSION LINE FOR NITRATE AGAINST THE FLOW IN CHENANGO RIVER ABOVE CONFLUENCE OF TIOUGHNIOGA RIVER.

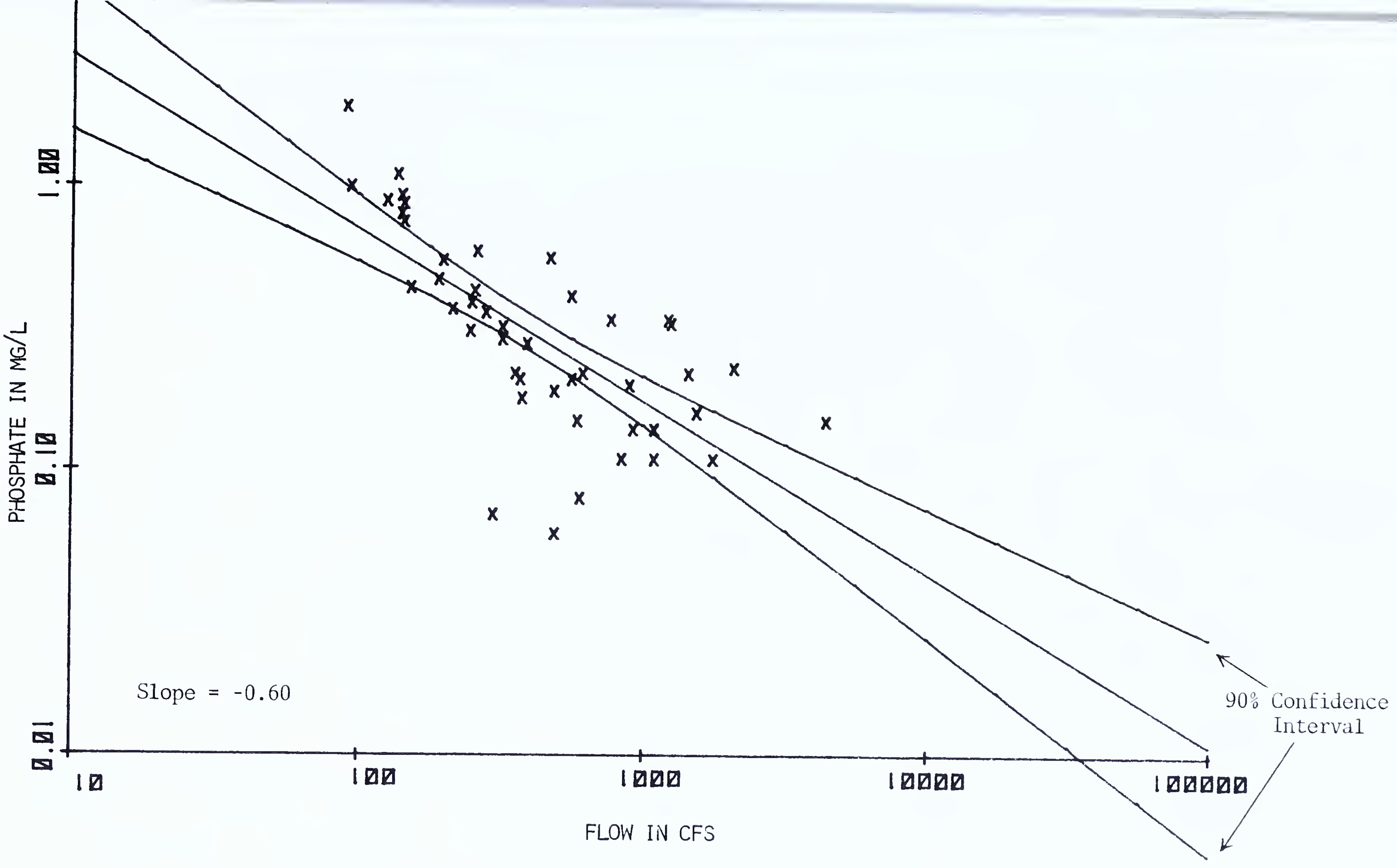

FIGURE 16A -- GRAPH SHOWING REGRESSION LINE FOR PHOSPHATE AGAINST THE FLOW IN TIOUGHNIOGA RIVER AT BLODGETT MILLS, NEW YORK.

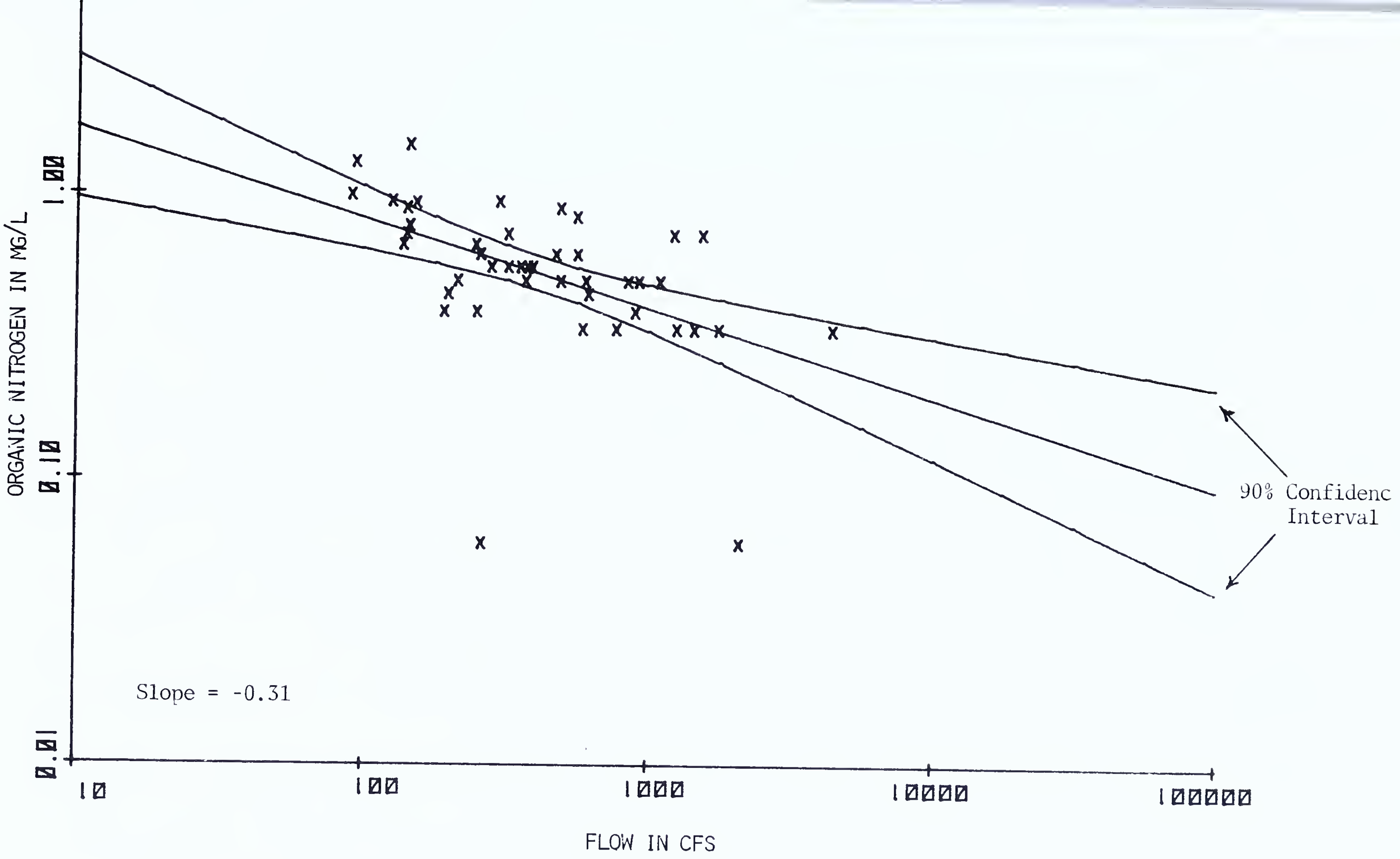

FIGURE 16B -- GRAPH SHOWING REGRESSION LINE FOR ORGANIC NITROGEN AGAINST THE FLOW IN TIOUGHNIOGA RIVER AT BLODGETT MILLS, NEW YORK.

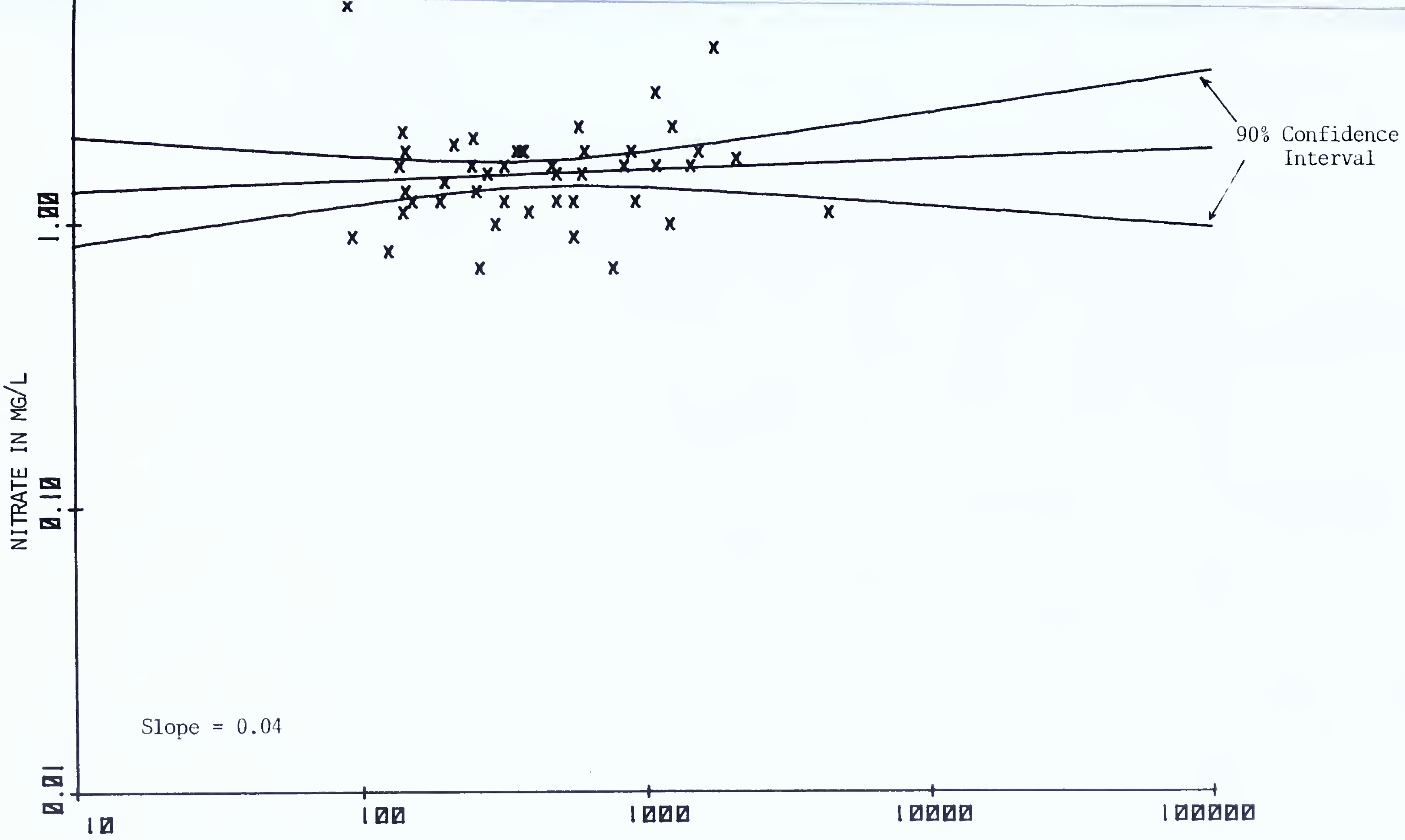

FIGURE 16C -- GRAPH SHOWING REGRESSION LINE FOR NITRATE AGAINST THE FLOW IN TIOUGHNIOGA RIVER AT BLODGETT MILLS, NEW YORK.

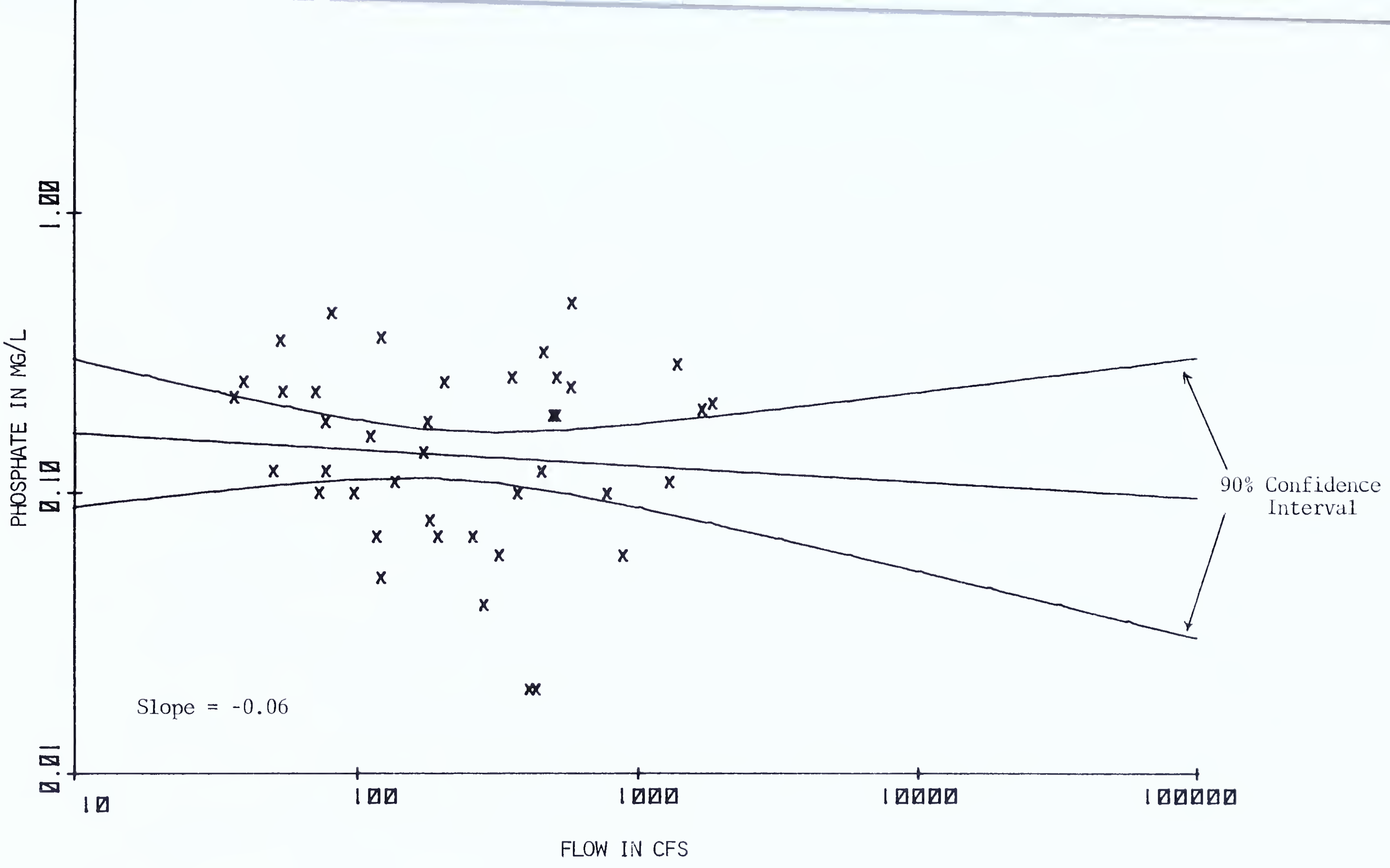

FIGURE 17A -- GRAPH SHOWING REGRESSION LINE FOR PHOSPHATE AGAINST THE FLOW IN CHENANGO RIVER AT SHERBURNE, NEW YORK.

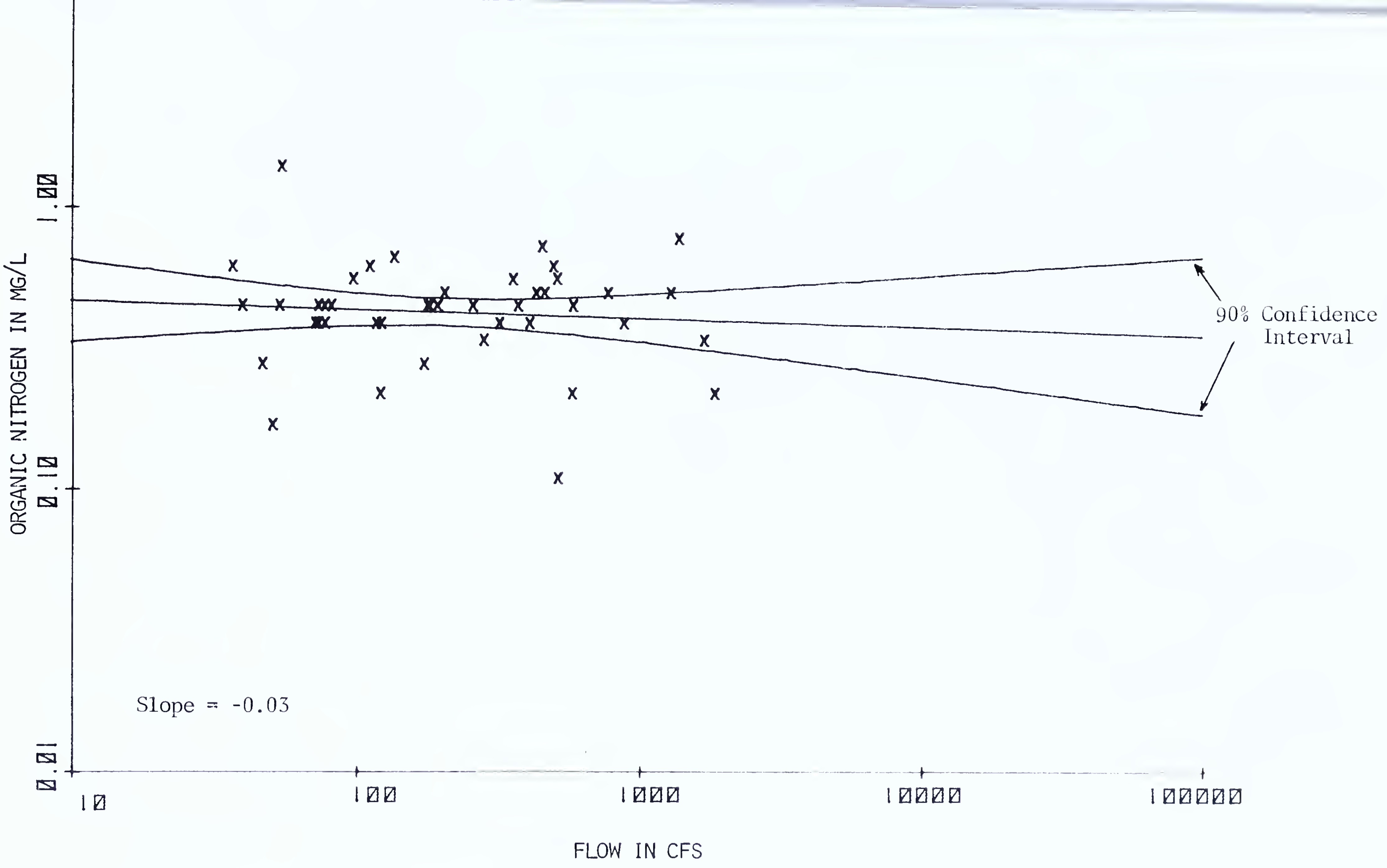

FIGURE 17B -- GRAPH SHOWING REGRESSION LINE FOR ORGANIC NITROGEN AGAINST THE FLOW IN CHENANGO RIVER AT SHERBURNE, NEW YORK.

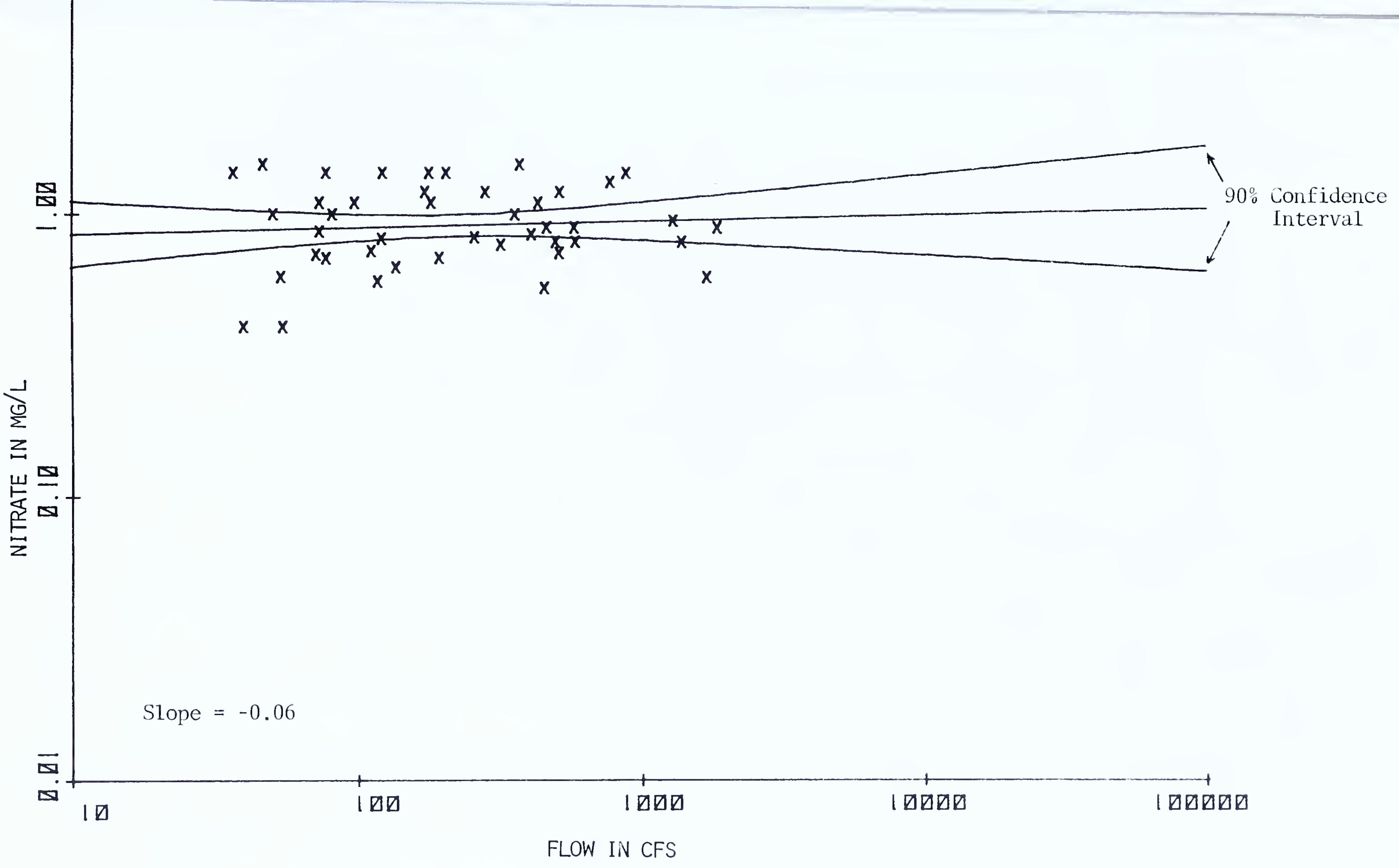

FIGURE 17C -- GRAPH SHOWING REGRESSION LINE FOR NITRATE AGAINST THE FLOW IN CHENANGO RIVER AT SHERBURNE, NEW YORK.

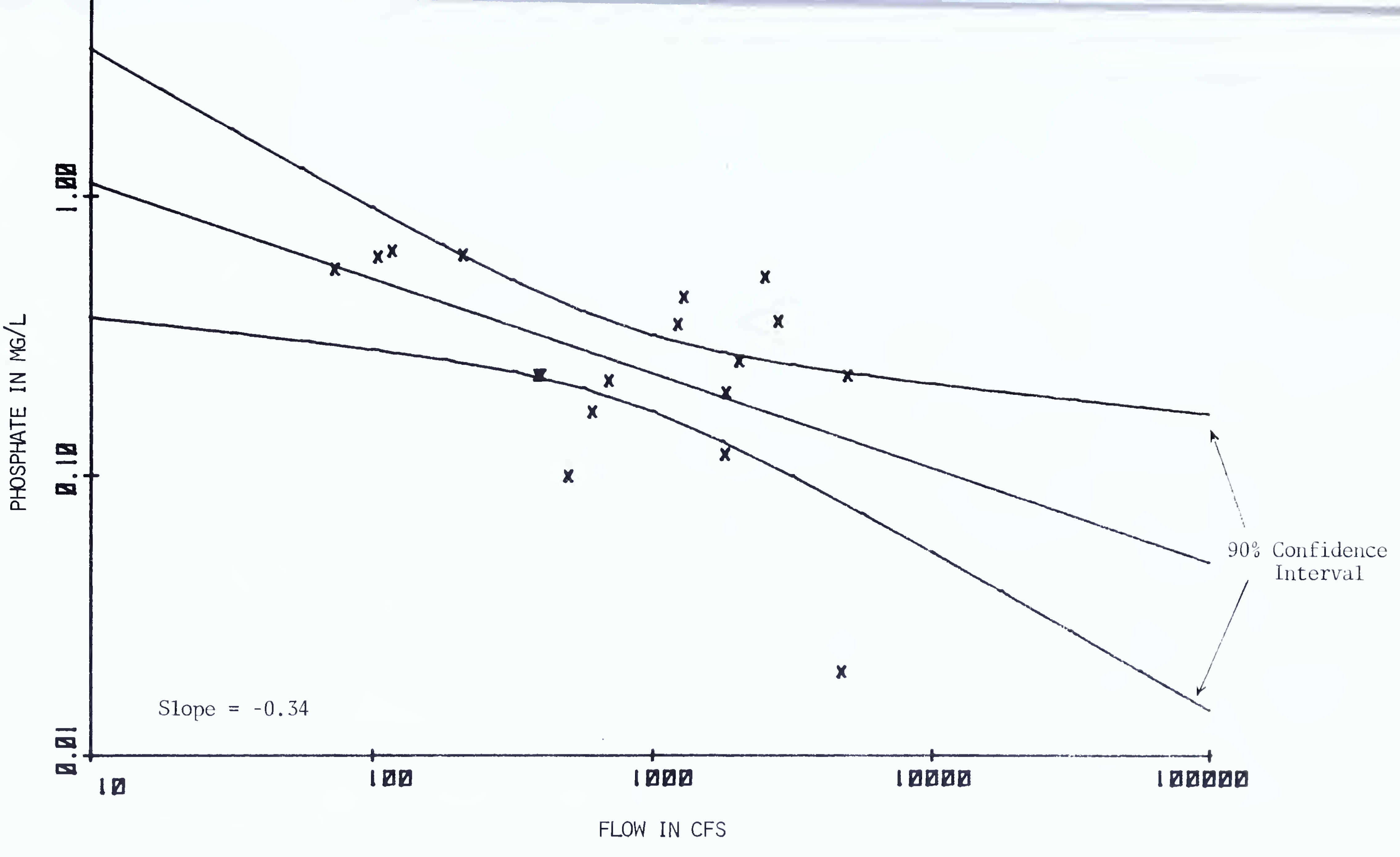

FIGURE 18A -- GRAPH SHOWING REGRESSION LINE FOR PHOSPHATE AGAINST THE FLOW IN TIOUGHNIOGA RIVER AT ITASKA, NEW YORK.

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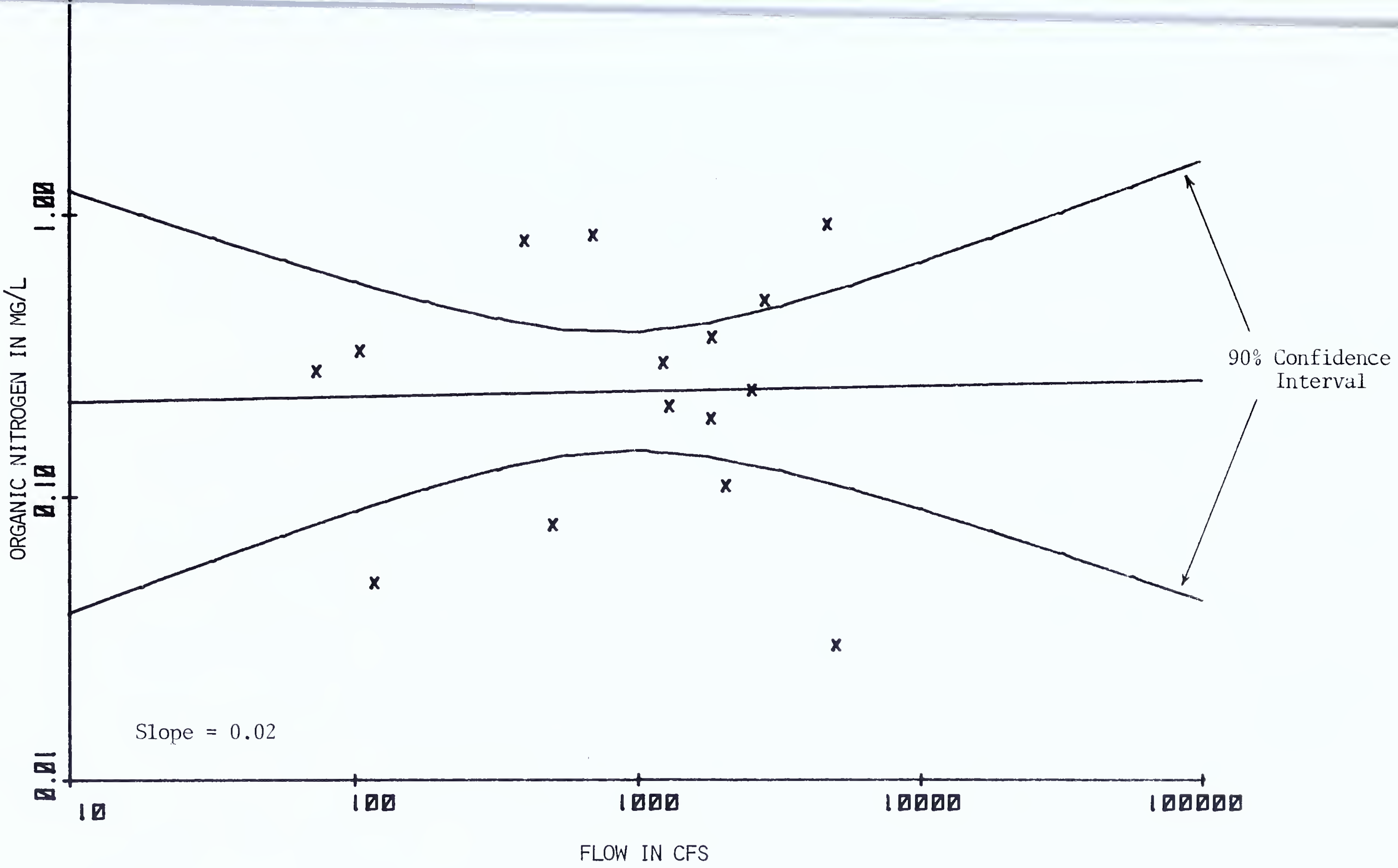

FIGURE 18B -- GRAPH SHOWING REGRESSION LINE FOR ORGANIC NITROGEN AGAINST THE FLOW IN TIOUGHNIOGA RIVER AT ITASKA, NEW YORK.

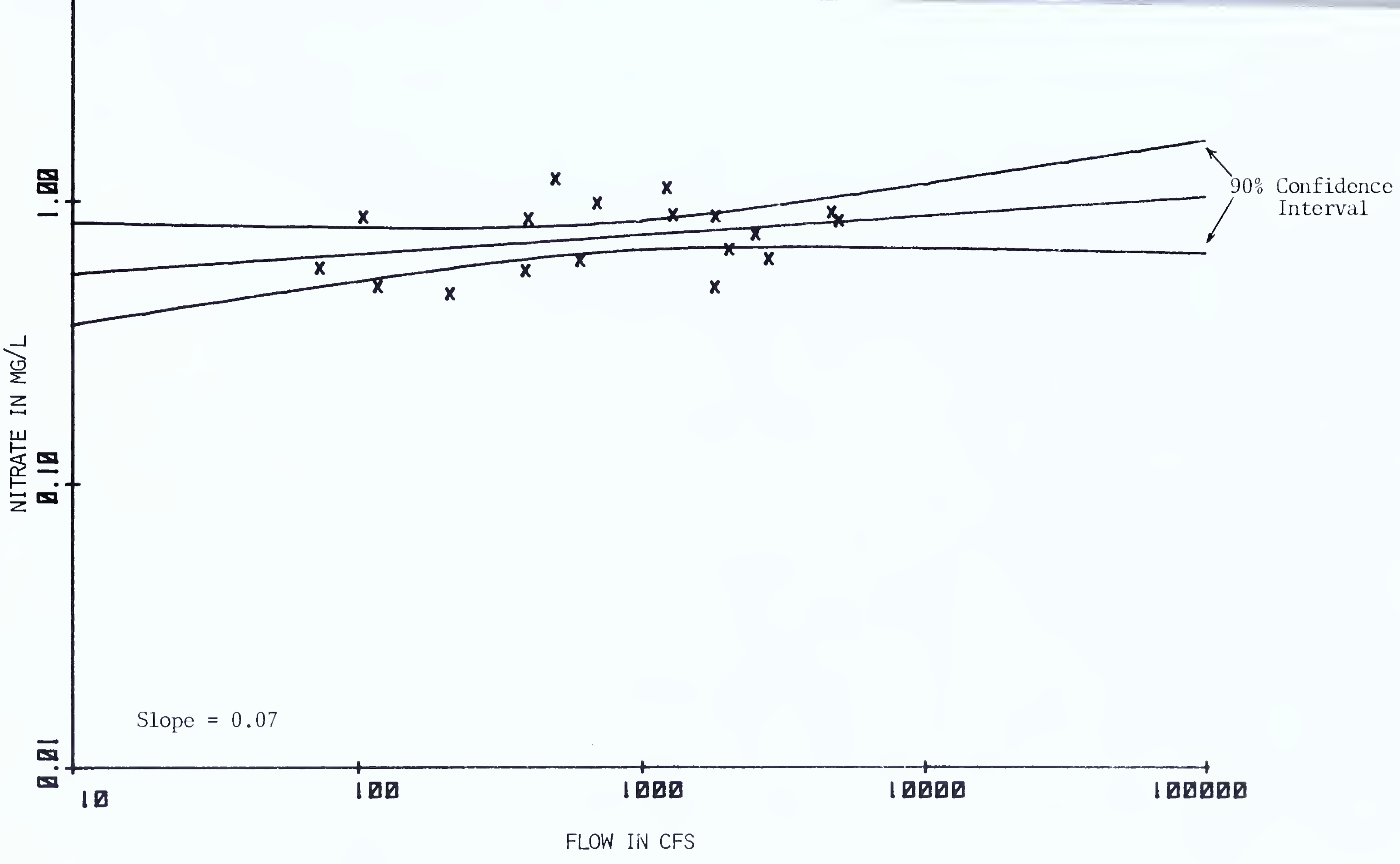

FIGURE 18C -- GRAPH SHOWING REGRESSION LINE FOR NITRATE AGAINST THE FLOW IN TIOUGHNIOGA RIVER AT ITASKA, NEW YORK.

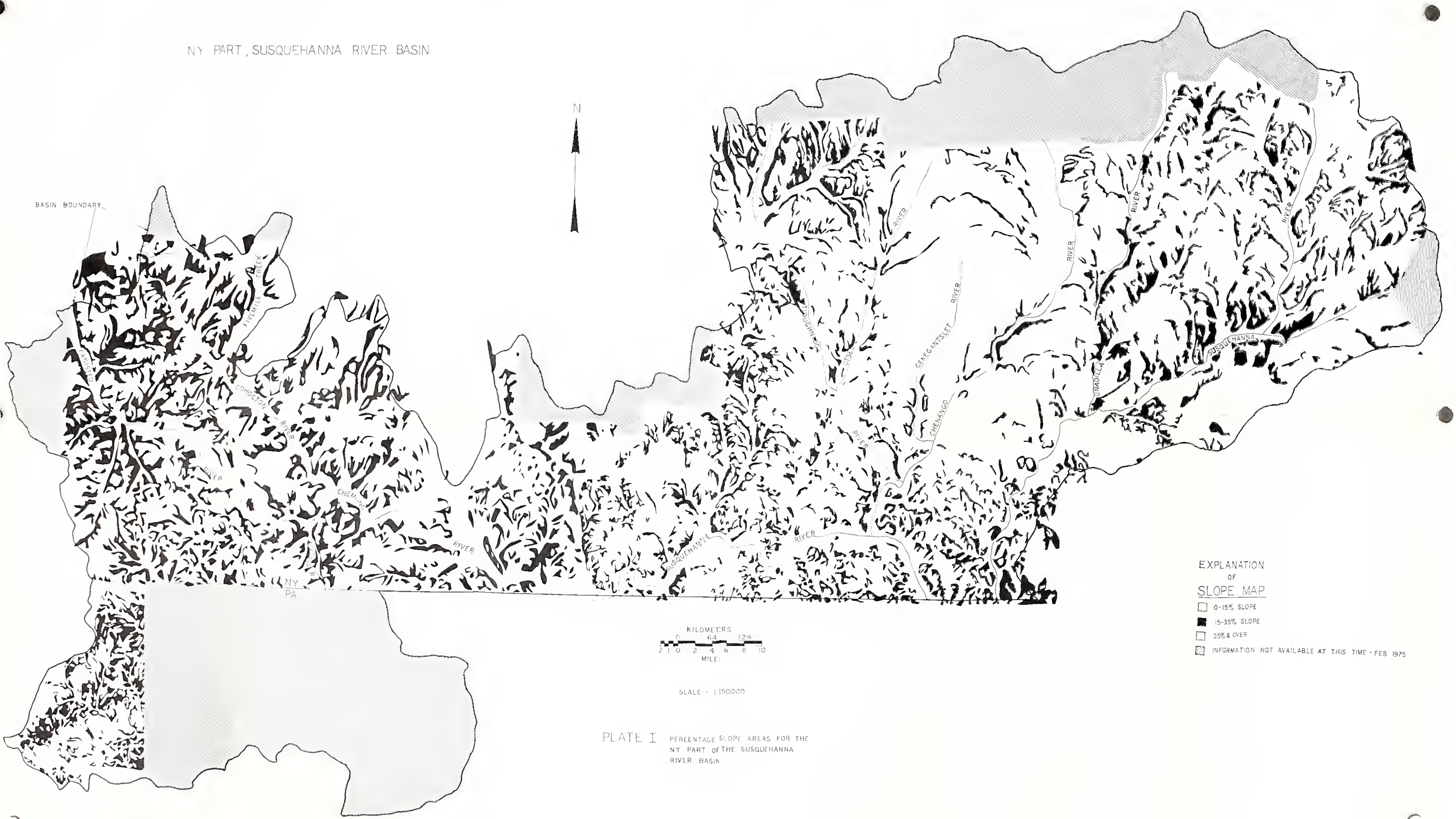

PLATE I PERCENTAGE SLOPE AREAS FOR THE NY PART OF THE SUSQUEHANNA RIVER BASIN

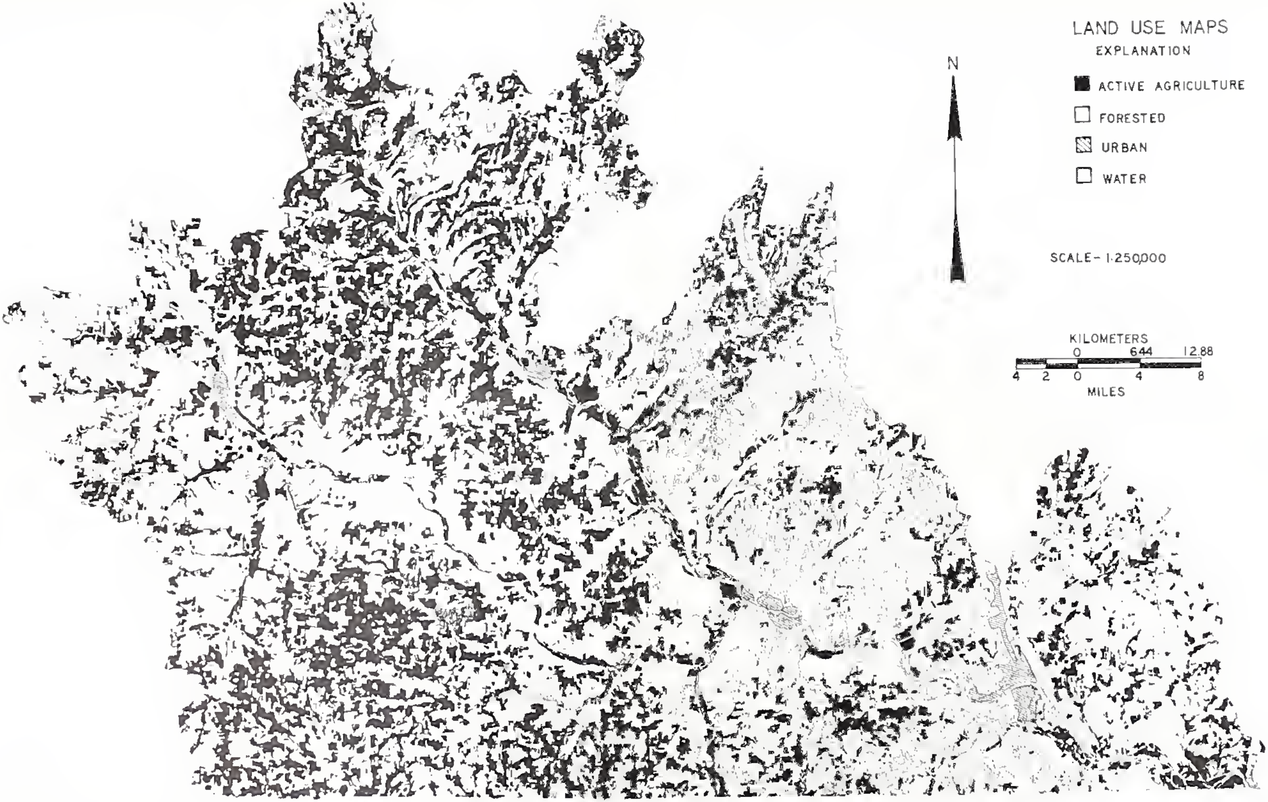

PLATE II - LAND USE AREAS FOR THE CHEMUNG RIVER SUBBASIN IN NEW YORK

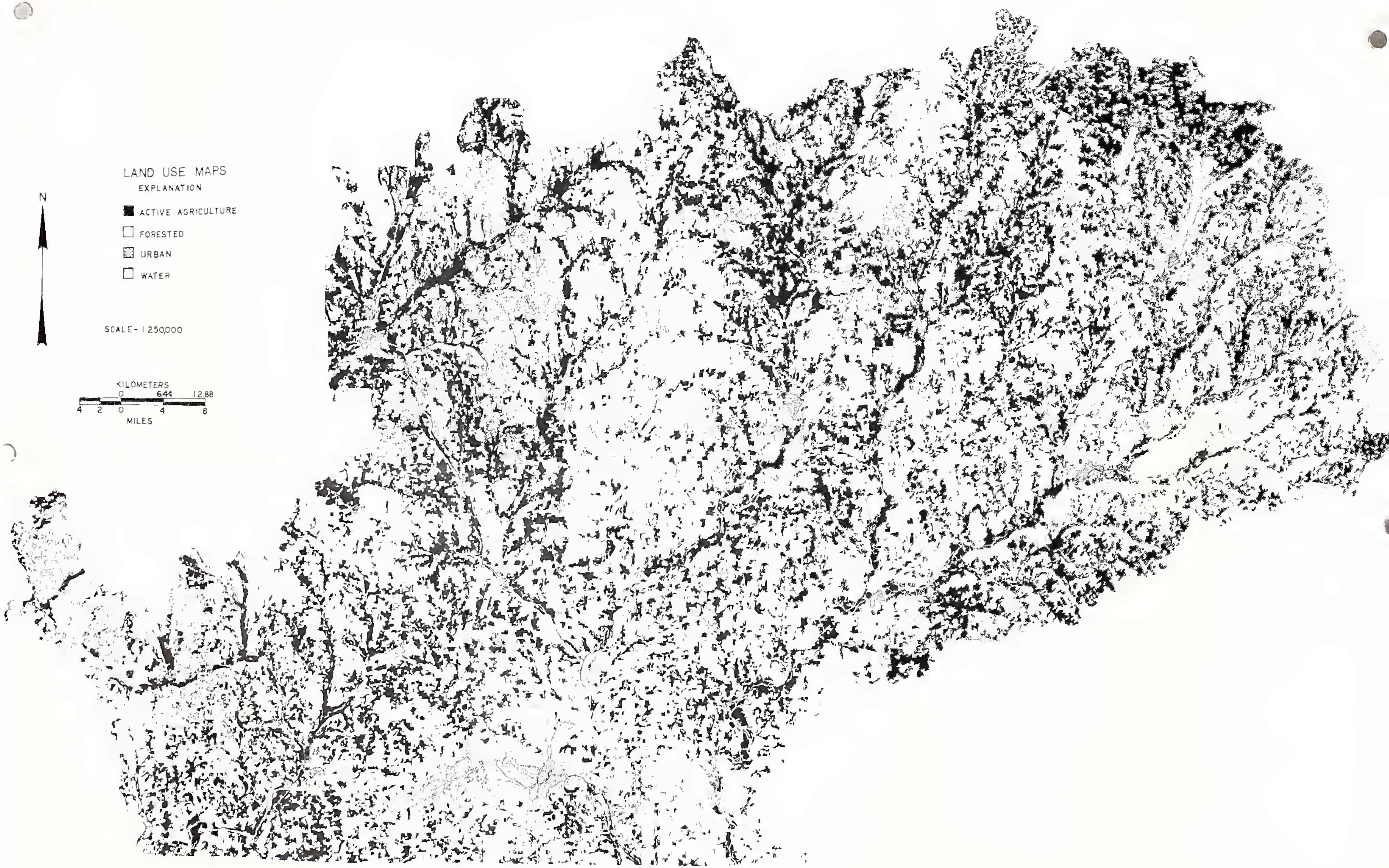

PLATE III - LAND USE AREAS FOR THE SUSQUEHANNA RIVER SUBBASIN IN NEW YORK